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THE HOUSE OF COMMONS NEW SIGNAL LIGHT.

We give illustrations and particulars of the new all-round signal light, which was lately shown for the first time in use in the clock tower above the great clock at St. Stephen's.

The old lantern—which was in use from the year 1874 up to the end of the last Parliamentary session—could only be seen on the western side of the tower through an arc of a circle of 210°, and consisted of two of Wigham's bi-form gas burners inclosed in a lantern, which was placed on wheels to allow it to be run out to one side of the tower at night in order to indicate to members of Parliament in the West End clubs when "the House" was sitting.

Referring to the illustrations, Fig. 1 represents a view of the interior of the chamber, situated above the peal of bells, showing the new lantern in position. Fig. 2 shows the lantern in elevation, partly sectional. The floor of this chamber—which is open on all sides—is about 250 ft. above the ground. The lantern consists of a second-order dioptric apparatus, consisting of a refracting belt, with top and bottom elements 830 mm. in height and 1 m. 40 mm. internal diameter, made of highly polished glass. The burner, which is placed in the focus of the refracting belt, is a "Wigham" light-house gas burner of 68 jets, constructed by Messrs. Edmundson & Co., Dublin.

The jets are so placed with regard to each other that, when drawn into shape by the overhanging iron flue, with talc terminal, a solid mass of flame, about 8 in. in diameter by 6 in. high, is produced with a consumption of gas of about 240 cu. ft. per hour, and with an illuminating power of 2,400 candles, or about 10 c. p. per cubic foot of gas consumed per hour. By this arrangement the light from the naked flame falls without any interruption upon every portion of the surface of the dioptric apparatus. The whole is inclosed within a substantially constructed glazed lantern 9 ft. diameter and 12 ft. high. As the lantern stands within the tower and is practically invisible from the ground—the light being thrown through the openings between the stanchions supporting the spire—it is necessary to have a large body of light, so that the principal supports at the four corners of the tower may not seriously intercept, but allow of a beam of light being thrown throughout the entire circle. A by-pass valve is arranged in addition to the main gas valve to allow access of a small quantity of gas to the burner when the latter is not in full use. If deemed desirable in order to make the signal more distinctive, a system of flashes can readily be imparted to the light by clock-work mechanism attached to the valve. The lamp, with the exception of the lens and burner, has been constructed and erected by the lighting staff of the Houses of Parliament, under the direction and to the designs of Mr. William J. Prim, the resident engineer.—*Industries*

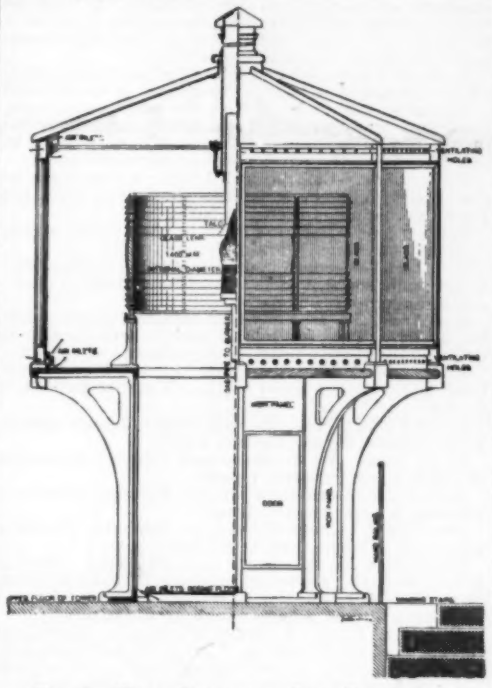

FIG. 2.—HALF SECTIONAL SIDE ELEVATION.

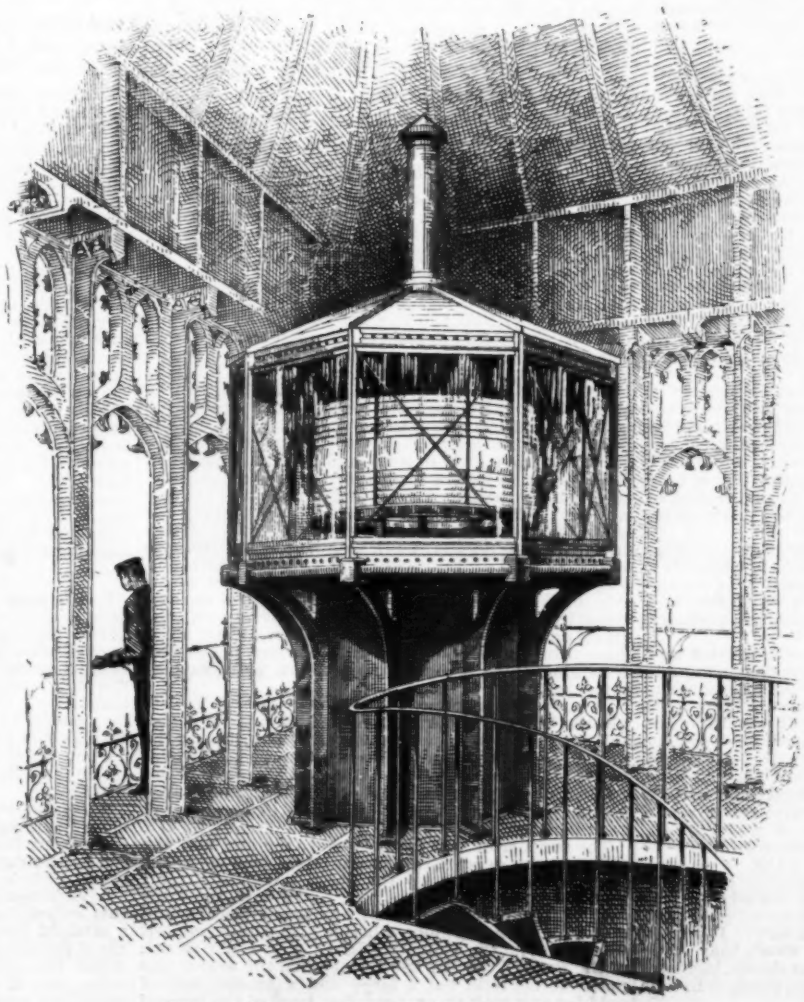

FIG. 1.—GENERAL VIEW OF CHAMBER AND LAMP.

THE NEW SIGNAL LIGHT OF THE HOUSE OF COMMONS.

COLORED FIRES.*

By E. J. KENNEDY, Ph.C.

No one can estimate the influence of the many colors and forms of flame upon the human race. The traditions of every people have been interwoven with the lineaments of flame. Humanity has been ushered into life surrounded by a halo of flame, and has been carried away and translated in chariots of fire.

The literature of every nation has used its descriptive terms and clothed its lights and shadows in the beautiful colors, the idioms, poetry and imagery of fire. Supernatural power has existed in the burning bush, in the flaming cloud and in the consuming fire. Their flaming colors portrayed the sword that guarded the gates of Paradise, and the radiant light that clothed Deity himself. They have cast the ray that lighted mankind to Elysian fields and the *ignis fatuus* that carried him through Cimmerian gloom and Stygian darkness to the sulphurous regions of the damned; the "Will o' the Wisp" that "on the wild moor or bog" led many a traveler to destruction.

They have made the abodes of the blessed of every tongue refulgent beams, and the abodes of the lost "lakes of fire and brimstone." Man had seen them in the great upheavals of nature. He saw them issue from the mountain's torch. He saw them in the twilight of time, in the meteor's flash and in the comet's wake. He knew that this world had once been clothed in fiery mist, and that the burned-out energies of the moon told him of a lifeless satellite—the product of spent forces. Their presence represented to him power, life and activity; their absence denoted decay and death.

Tradition tells us that symbolic fires burned brightly in the valley of the Euphrates long before the pyramids were erected, and that the altars upon which they burned were guarded and religiously fed by a consecrated and magical body of priesthood who recognized a deity in the essence of an eternal fire.

Flames in all ages have surrounded the martyr at the stake and ignited the fagots of persecution, and have mingled in some way with the fumes of incense as it arose heavenward, and the sacrifice as it smoked upon the altar appeasing some Great Spirit. One can scarcely wonder at the great veneration of the "lurid red" of the mysterious flames whose origin was so utterly incomprehensible. The earlier nations ascribed them to the supernatural, and considered them a type of divinity. It is not strange, then, that colored fires should intimately be associated in the world's history with civilization as well as barbarism, the religious as well as the profane; that they have been wielded by a crafty priesthood and awed into subjection ignorant and superstitious peoples; that they have paid homage to the dead and victory to the living; that they have lightened the sepulture of heroes and celebrated the birth of royalty.

They have alike celebrated the flush of victory and their embers have died away in defeat; have glorified independence and acknowledged submission; illuminated the halls of freedom and smouldered on the hearthstone of servitude; enlightened the wings of peace and belched forth from the terrible enginery of war. One has but to read history to recognize their influence and power, and he will say, as did Napoleon when he witnessed the burning of Moscow: "The mountains of red, rolling flames were, indeed, like immense waves of the sea," etc.

To the common observer, living even in this age, colored fires have a savoring of the mysterious and the supernatural. To the druggist, as he is called upon to prepare them upon the small scale, the subject resolves itself rather into the practical application of known facts in return for the few paltry shekels he expects to receive. Colored fires are so inseparably connected with the art and manufacture of destructive agents and explosive compounds that it is impossible to separate them. To really understand them one should begin with their history, color, composition, purity of constituents used, preparation, and in a general way the chemistry and products of combustion, as well as the kinds, uses, accidents and causes, spontaneous ignition, etc. The art of making colored fires is of unknown antiquity. History asserts that it was practiced in China from the earliest times, and, together with the making of fireworks, had no doubt attained a perfection unknown in other countries; at any rate, it preceded that of gunpowder. It was an art practiced by the early alchemists, who give descriptions of some of their combustible compounds. It is of interest to notice in this connection, perhaps, a few of them. One was "automatic fire," which was made from equal parts of sulphur, saltpeter and black sulphide of antimony, finely pulverized and mixed and made into a paste, with equal parts of the juice of the black sycamore and liquid asphaltum, a little quicklime being added. It was also directed to keep the material from the sun, which would set it on fire. Another compound, well known by name, at least, and made by the earlier alchemists, was "liquid or Greek fire." It was believed to contain sulphur, saltpeter and naphtha, but as its composition was kept a state secret at Constantinople no definite knowledge of it was obtained. It is interesting in this connection to speak of gunpowder. For the earliest known record of it we are indebted to Marcus Græcus, who lived probably about the close of the eighth century. He gives it quite explicitly thus: "To pulverize in a marble mortar, 1 lb. of sulphur, 2 lb. of charcoal and 6 lb. of saltpeter;" and further tells us that if some of this powder be put in a long tube, narrow, and closed at one end, that it would fly through the air when set on fire—which is clearly the rocket. He also gives us recipes for making the skin incombustible, so that one could handle fire without being burned, and "wash his hands in melted copper and sit at ease in burning straw."

Color.—It is not the purpose of this paper to attempt to give in detail the signification of colors, their primitive allusions or emblematical significations, but to notice in a general way a few of the ideas

* Detroit Pharm. Society Proceedings.—*Western Druggist.*

which have been inseparably connected with the colors of fire since remote antiquity. It is needless to say that if red signified the color of flames themselves it also signified blood, and so on through the whole category. Blue was emblematical of the azure-colored cerulean sky. Green, that of nature's own garb. Yellow, sacred to the sun. White, that of Paradise and eternal day, and as opposed to pandemonium, sable, murky darkness and the blackest midnight. It will be seen by this that both primary and complementary colors had a multiplicity of significations and as such were significant of many meanings. It is a noticeable fact that color is almost always a necessary accompaniment of light and heat. Botanists tell us that some time in the history of every plant the three primary colors are always developed; the blue and the yellow forming the green of the leaves and the red that of the fruit or russet of the bark, as also the primary colors are restored and reappear in the aniline colors from coal tar which a carboniferous forest stored up from the sunlight ages gone by.

Composition.—Colored fires can be divided into two parts: The combustible and the coloring compounds, including also those substances which aid combustion by yielding oxygen. Of these may be mentioned charcoal, lampblack, sulphur, stearin, shellac, resin, sugar, and others. Of the salts which color flame are the carbonates, chlorates, chlorides, nitrates and sulphides, among which Na_2CO_3, $KClO_3$, KNO_3, $Ba(NO_3)_2$, $Sr(NO_3)_2$, Sb_2S_3, As_2S_3, CuO with H_2BO_3, magnesium wire, and others.

It will be noticed that sulphates are scarcely ever used, which is probably from the fact that they are as a rule acidulous, and therefore might cause the compound in which they are used to inflame spontaneously.

The light of a flame depends on several circumstances. It is a well known principle in physics that light in most cases depends upon the *solid incandescent particles* as well as the temperature, and that the color of a flame depends upon the *kind of solid particles* it contains, as sodium renders a flame yellow and strontium red, and, further, there are cases where the temperature of the gas before combustion affects the color of the flame, as with carbonic oxide, the cold gas giving a blue and the hot gas a yellowish flame. For this statement reference is made to experiments of Tidy and others.

Purity of Chemicals Used.—Of the purity of chemicals used too much cannot be said, and more especially in compounds where $KClO_3$ is one of the constituents. This subject has, no doubt, given the compounder more trouble and the purchaser more poor results than any other, as also it has been the cause of more serious results than anything else. In referring to a few of the possible contaminations, the more important ones only can be noticed here. Sulphur is often contaminated with H_2SO_4, which is quite likely to cause spontaneous ignition.

$NaNO_3$ is often substituted for KNO_3, and is mainly injurious in three ways: First, from the well known nature of the salt, which is very hygrometric, absorbing and retaining moisture to such an extent that it oftentimes fails to burn. Second, it changes the color to an intense yellow. Third, it has much less powerful oxidizing properties than KNO_3. Black sulphide of antimony is often adulterated with coal dust to such an extent as to completely change the desired effect. Much more might be said about impurities, but enough has been said to show that, whatever impurities there may be, they produce correspondingly poor results and often dangerous ones.

Preparation of Ingredients Used.—This is essentially the keynote to the whole matter. One can have chemically pure ingredients, yet if not properly prepared can expect nothing but failure. Reference has been made to the hygroscopic character of $NaNO_3$. It is not alone in this. Most of the salts used have a similar tendency to absorb moisture. As this retards ignition, sometimes quite entirely when not thoroughly dried, all substances should be well dried. This may be done, some authorities say, by exposure in shallow trays to the sun's rays or a dry atmosphere. This seems to be, however, only used by manufacturers. Upon the small scale, where time and space are economy, we believe in drying the salts by placing in a gentle heat from the stove. Each substance, after having been thoroughly dried, should be pulverized separately, and preferably at the time of compounding.

We believe manufacturers prepare a fine powder of $KClO_3$ by making a supersaturated hot solution to become cold with constant stirring, when the salt will be separated in the form of a very fine crystallized flour, which is dried by exposure to gentle heat. Of course, this is impracticable for small amounts, but it may readily be powdered alone. Shellac may be ground in a mill or coarsely powdered, for when too fine it melts and does not burn as readily.

Mixing should be done with a wooden or bone spatula, on paper, or may be done by sifting through a coarse sieve or mosquito netting: at all events, the use of the mortar and pestle is extremely dangerous and should never be resorted to in mixing the prepared constituents.

Products of Combustion.—The decomposition and changes occurring during combustion of pyrotechnic mixtures are not very well known. According to the best authorities, they cannot be represented by even a comparatively complicated equation, on account of the multiplicity of conditions and circumstances governing them. To illustrate: Most of them are constructed upon the type of gunpowder. We can only give in a general way the chief reactions for gunpowder when it is fired, and, as nearly as can be ascertained, it would be represented thus: $2KNO_3+S+3C=K_2S+2N+3CO_2$. Change these conditions and it becomes $4KNO_3+4C+S=K_2SO_4+K_2CO_3+4N+2CO_2+CO$.

Causes of Explosions.—The explosive power depends upon the rapid combustion of the mixture and the sudden liberation of a large volume of gas which may occupy many times the original bulk. It is then easy to see how friction or sudden shock may cause explosion. This danger, Thoener has shown, increases with age as the point of inflammation changes in time and becomes lower. . . . . .

Failures.—The literature of pharmacy of our own country and others is replete with formulas and recipes without number. It is not difficult to find good formulas, but it is sometimes exceedingly aggravating in the extreme to have either a partial or a complete failure with one's preparation. The causes of failure may or may not have been noticed in this outline, but enough has been said to show what impure constituents, careless compounding, ignorant manipulation, and dangerous and explosive ingredients may do. We believe good results may be obtained from any formula if due regard is exercised as to purity and preparation of the constituents used, more care and less haste in compounding, and an ordinary intelligence and common sense in the using and igniting of the same. . . . .

FORMULAS FOR COLORED FIRES.

Considering the numerous and constantly recurring inquiries for formulas for colored fires for tableaux, landscape illumination, and processions, a few approved formulas are here reproduced, in part from our back numbers and partly from our exchanges. It must be borne in mind that fires containing sulphur must never be burned indoors, for which purpose those with stearic acid or milk sugar usually are preferable.

In the four formulas first following (especially adapted for theatrical purposes) the shellac or stearic acid respectively are to be melted, the other substances, previously finely powdered and mixed, carefully introduced, and, after cooling, the mass is to be reduced to powder. Press the powder into proper paper cones.

White Light.—Stearic acid, 1 part; barium carbonate, 1 part; milk sugar, 4 parts; potassium nitrate, 4 parts; potassium chlorate, 13 parts.

Green Light.—Barium nitrate, 4 parts; milk sugar, 4 parts; potassium chlorate, 8 parts.

Red Light.—Strontium oxalate, 1 part; lycopodium, 1 part; milk sugar, 4 parts; potassium nitrate, 4 parts; potassium chlorate, 13 parts.

Red Light, No. 2.—Strontium nitrate, 12 parts; shellac, 3 parts. This formula is said to produce a most brilliant effect, with nearly entire absence of smoke.

Red Light, No. 3.—Strontium nitrate, 3 parts; potassium chlorate, 1 part; shellac, in coarse powder, 1 part.

Green Light, No. 2.—Barium nitrate, 3 parts; potassium chlorate, 1 part; shellac, 1 part.

Green Light, No. 3.—Boric acid, 3 parts; potassium chlorate, 1 part; shellac, 1 part.

Yellow Light.—Sodium nitrate, 3 parts; potassium chlorate, 1 part; shellac, 1 part.

Blue Light.—Ammonio-copper sulphate, 3 parts; potassium chlorate, 1 part; shellac, 1 part.

Green Fire No. 4.—(Quick and brilliant.) Barium nitrate, 40 parts; potassium chlorate, 36 parts; sulphur, 24 parts.—(Slow burning.) Barium nitrate, 71 parts; potassium nitrate, 8 parts; sulphur, 21 parts.

Red Fire, No. 4.—(Quick and brilliant.) Strontium nitrate, 39 parts; potassium chlorate, 40 parts; sulphur, 18 parts; charcoal in fine powder, 3 parts.—(Slow burning.) Strontium nitrate, 68·5 parts; potassium chlorate, 9 parts; sulphur, 22 parts; charcoal, 0·65.

Orange-red Fire.—Chalk, 17 parts; potassium chlorate, 26 parts; sulphur, 7 parts.

Blue Fire, No. 2.—(Quick and brilliant.) Copper sulphate, 7 parts; calcium carbonate, 25 parts; potassium chlorate, 52 parts; sulphur 16 parts.—(Slow burning.) Copper sulphate, 6 parts; malachite, 22 parts; sulphur, 15 parts.

Violet Fire.—Calcium carbonate, 2 parts; malachite, 2 parts; potassium chlorate, 6 parts; sulphur, 2 parts.

Purple Fire.—Copper sulphide, 1 part; strontium nitrate, 14 parts; calomel, 14 parts; potassium chlorate, 15 parts; shellac, in coarse powder, 5 parts. On account of the mercury contained, this powder must not be burned in closed rooms.

WHERE THE COLUMBIA RIVER GOLD COMES FROM.

The placer gold found in the northern part of the State of Washington, on the banks of the Columbia River, is very fine scale gold. The pay dirt is only six inches in thickness, except in places where it has lately been washed down from the original deposit. At same level on each side of the stream, about six feet above high water mark, is seen the strata of red and brown earth and gravel that carries the dust. The gravel is about the size of a pin head to bowlders that are from four to eight inches in size each way, generally flattened both sides and twice the width in length. This coarse gravel is made of several kinds of rocks, granite predominating, considerable quartz, some greenstone and slate, but few of the brimstone, dolomite. So the character of the gravel helps determine whence the gold came from. There is no gold found higher up on the benches; so we must conclude that the deposit was made at one period of time and at a comparatively late date. There are no large nuggets found, only one kind of gold and nearly of one size; the shape of this dust gives it a peculiar motion under water. None is found on bare rocks in low water, but very little in deep channels that have become dry; the most favorable place is in shallow water with but little current and at high water mark, and it is spread evenly with the gravel on benches of 300 feet or less in width; all of these things must be taken into account in order to determine where it came from and how far it traveled before resting.

In early days an ounce per man per day with sluices was the best pay reported from reliable sources, generally one-fourth that much was taken out; finally the Chinamen worked large fields of it, not making over $1.50 per day, and even less. No doubt there are places on the Colville reservation side of the river and in that portion soon to be thrown open to the explorer, many good bars that will remunerate with sluice and rocker.

The summer of 1892 I concluded to try and find the source of this deposit, thinking it might lead me to the mother lode. Going up the Pend d'Oreille River I found the same deposit of rock and gravel, the same gold with another kind that was much coarser and darker in color and more valuable. The same deposit was found on the Columbia River above the mouth of the Pend d'Oreille. So I concluded the source was not a mother lode, but a large and extensive belt of gold-bearing rock at or near the head of the several streams putting into the Columbia from the east. Going up Little Salmon River the same deposit was found at the forks of the stream, showing plainly that both forks had their supply of gold from the same field, and therefore it was to the north and east. Sullivan Creek, that empties into the Pend d'Oreille several miles above the Salmon, has the reputation of having the same kind of gold in a lesser degree, and that stream comes from the northeast. So by the map one can locate this gold field that I found to be from three to fifteen miles wide and of unknown length, at least thirteen miles long. Following up the south fork of the Salmon River (I will say here that the coarse gold on the Salmon River is supplied by ledges within six miles of the mouth of that stream, as none of that kind of gold is found above that point, probably in or near the mineral belt discovered by Death-on-the-Trail Proctor last season), most of the country rock for the first fifteen miles is dolomite, not much show for a gold ledge in such rock; then comes a dike of mica slate with large veins of quartz miles in length. Here was supposed to be the mother lode, but each one proved to be barren, yet up the stream into dolomite again I found colors to every pan of the same character as that found on the Columbia. As we approach the head of the south fork the gulches are deeper, the timber larger, the mountains higher, the Sullivan interlocks with the Salmon and Priest Rivers, a sharp divide between each that runs up into ragged peaks where snow remains the year round. Here all the panning fails to raise a color. Had I passed the mother lode? To be sure there is a dike of chloritic slate 1,000 feet wide crossing from north to south full of pockets of cellular quartz, but two weeks of hard work proves that there is nothing in it. So up the highest peak, 8,000 feet high, to see what kind of rock is there—on the east side of that mountain, called Snow Mountain by prospectors, lay tilted over on its side a rock nearly a mile in thickness that was once a placer field, now turned into stone. There were all kinds nearly of round water-worn pebbles and bowlders embedded in this slate rock, from the size of a pea to four-foot granite and quartz, shaped like hens' eggs and sticking out where the broken places occurred. Some strata of brown color were taken and pounded up and panned out, and the proof showed with a half dozen colors of Columbia River gold.

The higher peaks of that divide, cut by tributaries of Priest River, Sullivan Creek and Salmon and Kootenai Rivers, hold the remnants of a once mighty placer field. Those mountain tops were once a valley, and before that a mighty flood passed through it carrying from the far north the gravel, sand, gold, clay and sediment that ages after made what is called conglomerate rock. The forming of channels, draining this large scope of country by the streams mentioned above, lowered the ledges of this plateau; what was left is now our mountains, the rock tilted over toward valleys or entirely washed away, down to the bed rock beneath the later deposit. The absence of colors on the western slope in the near vicinity of the summit goes with the fact that there the conglomerate is all gone down the valley. Many hundreds of feet of the underlying limestone is cut out. So no colors could remain under such circumstances.

I could give pages of argument in favor of this theory, but prefer for want of space to give you these few cold facts. It may save some other prospector months of labor and disappointment. It well repaid me for the summer's work.—*H. S. Back, in Northwest Mining Review.*

JAPANESE INSTRUMENTS FOR THE EARTHQUAKE LABORATORY AT THE CHICAGO EXPOSITION.

The first earthquake instrument ever invented, a drawing of which is shown on the wall, is in all probability that of Choko, dating from the year A. D. 132. The first instrument used for keeping systematic records in Japan was Palmieri's modification of the contrivance sketched out by the late Robert Mallet. Since this not only have all forms of seismographs and seismoscopes employed in Europe and America been employed, but many special forms have been designed in Japan, with the result that rather than Japan borrowing from Europe and America, these countries are using inventions which had their origin in Japan. A few of these instruments are exhibited in this laboratory. The main feature in their construction is that they all work from "*steady points*," and for small earthquakes at least, we can say with confidence that the diagrams they yield are absolute measurements of the earth's motion. From diagrams written on stationary plates we know the extent and the direction of the principal vibrations in a shock, but when the movements are recorded on a moving surface, we know the period or the rapidity with which the movements follow each other. From these latter diagrams the acceleration or suddenness of movements may be calculated, and the factors given to engineers, enabling them to construct to resist known forces, rather than simply building strongly because an earthquake is strong.

INSTRUMENTS EXHIBITED.

1. *Seismograph Writing on a Glass Disk.*—Here we have horizontal pendulums writing the earth's motion as two rectangular components on the surface of a smoked glass plate. The vertical motion is given by a vertical spring lever seismograph. The rate at which the plate revolves is accurately marked by an electrical time ticker. The movements of the latter are governed by a pendulum swinging across and making contacts with a small vessel of mercury.

The revolving plate is kept in motion by clockwork, which is set in motion by an electric seismoscope. (See No. 8.)

2. *Seismograph Writing on a Drum.*—In this instrument the record is written on a band of paper, the diagram being less difficult to interpret because it is written to the right and left of a straight line and not round a circle.

3. *Seismograph Writing on a Band of Paper.*—In this instrument not only is the diagram written along a straight line, but it is written with pencil—the trouble of handling smoked paper being therefore avoided. When the earthquake ceases, the drum ceases to revolve, but if a second or third earthquake should occur, it is again set in motion. By this means a series of earthquakes may be recorded, the resetting of the instrument being automatic.

4. *Seismograph without Multiplying Levers.*—This

instrument is intended to record large motions, the horizontal levers not being prolonged beyond the steady points to multiply the motion. For large earthquakes, when the ground is thrown into wave-like undulations, special instruments which measure tilting are employed.

5. *Duplex Pendulum Seismograph.*—In this case a steady point is obtained by controlling the motion of an ordinary pendulum with an inverted pendulum. The record consists of a series of superimposed curves written on a smoked glass plate.

6. *Mantelpiece Seismometer.*—This is intended for the use of those who simply wish to know the direction and extent of motion as recorded at their own houses. It is a form of duplex pendulum, and it gives absolute measurements for small displacements.

7. *Tromometer.*—This is one form of an instrument which is used to record movements which are common to all countries, called earth tremors. Every five minutes, by clockwork contacts and an induction coil, sparks are discharged from the end of the long pointer to perforate the bands of paper which are slowly moving across the brass table. If the pointer is at rest, then a series of holes are made following each other in a straight line, but if it is moving, the bands of paper are perforated in all directions round what would be the normal line of perforations.

The earth movements which cause these disturbances are apparently long surface undulations of the earth's crust, in form not unlike the swell upon the ocean.

A more satisfactory method of recording these motions, which has been used for the last two years, is by a continuous photograph of a ray of light reflected from a small mirror attached to a small but extremely light horizontal pendulum.

8. *Electrical Contact Maker.*—These instruments are delicate seismoscopes, which on the slightest disturbance close an electric circuit, which, actuating electric magnets, set free the machinery driving the recording surfaces on which diagrams are written.

9. *Clock.*—At the time of an earthquake the dial of this clock moves quickly back and forth and receives on its surface three dots from the inkpads on its fingers. It thus records hours, minutes, and seconds, without being stopped.

10. *Model of an Earthquake.*—The bent wires represent the path traced by an earth particle at the time of the earthquake of January 15, 1887. The numbers indicate successive seconds. This model was made by Prof. S. Sekiya.

11. *Safety Lamps.*—These are lamps which if overturned are at once extinguished. One of these is a European invention and the other Japanese.

12. *Pictures.*—The pictures on the walls show the effects of the great earthquake of October 28, 1891, the devastation following the eruption of Bandaisan in 1887, and several of the more important volcanoes in Japan. They were made by Prof. W. K. Burton.

JOHN MILNE, F. OMORI.

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ARTIFICIAL IMITATION OF THE GEMINATION OF THE CANALS OF MARS.

IT may be said without exaggeration that for the past twelve years the planet Mars has constituted the sensational point of physical astronomy.

It was in 1882 that Mr. Schiaparelli, director of the Milan Observatory, discovered among the geographical delineaments of our celestial neighbor those straight lines seen again by various astronomers, and usually designated by the certainly improper name of canals.

What has not been said about the canals? After having denied them, as it is proper to do for every novelty, and finally forced to recognize the reality of them, one has made the most extravagant propositions in regard to them, even going so far as to suspect in them an artificial work that would at once reveal to us the existence of a Martial humanity, more or less analogous to that which has the advantage of counting us in its bosom. Thence, to nourish the hope of an interplanetary communication, there was but a step, and a number of writers of imagination have not hesitated to do so.

For our part, it will be so much the easier to leave aside this entirely gratuitous part of the considerations to which the study of Mars has served as a pretext, in that the positive result of the serious observations is itself very rich in unexplained peculiarities.

Thus, among the most singular features offered by the disk of the planet under consideration, all have agreed in giving a place apart to the phenomena of gemination, of which the canals of Mars are from time to time the theater.

Although it is well known, this word gemination merits an explanation. Mr. Schiaparelli has thus designated the duplication that is now and then presented by certain canals that were previously single, and which all at once exhibit themselves as two parallel lines exactly alike and separated by various distances that may reach to as many as 15°. The gemination does appear simultaneously upon the entire disk, but now here and now there. It seems that the seasons have an influence upon its production, and Mr. Schiaparelli first, and Mr. Perrotin after him, have noted a certain nebulous state of the atmosphere of Mars that appears to coincide with the phenomenon. Briefly, the illustrious director of the Milan Observatory cannot find sufficient expressions of admiration to render the astonishment that this division has caused him and other aerographers, and the learned Messrs. Terby and De Louvain, in the lead, are in accord with him in proclaiming in such gemination a phenomenon essentially different from anything that the terrestrial world offers us.

It is unnecessary to say that the hypotheses that are already so numerous in regard to the canals have prodigiously multiplied on the subject of the gemination; but there is some interest in enumerating here a few of the suppositions made, some emanating from eminent men and others that must attract attention by their singularity.

Mr. Boe, an author of Anvers, refusing all objective reality to the gemination, thinks that it constitutes an illusion resulting from fatigue of the eyes.

Mr. Daubrée, in a communication that the Astronomical Society of France has lately commended, sees in the geminate canals deep clefts in the planet's crust that widen under the influence of a general inflation undergone by the planetary globe.

With Mr. Fizeau it is a question of glacial crevasses, whose two edges give us the illusion of two parallel canals, and which recall, despite their incomparably greater dimensions, the rectilinear furrows of the Greenland *Inlandsis*.

It is also to cold that Proctor has recourse in his attempt at an explanation. According to him, the beginning of the thawing of gigantic rivers covered with snow ought to cause the appearance, in black, of the two shores on both sides of a middle region remaining white; that is to say, to bring about the appearances observed.

Mr. Flammarion is of the opinion that electricity intervenes to separate from each other two parallel trails of water (previously confounded) that was first brought to a state of viscosity that no fact of terrestrial physics can give us any idea of.

Finally, to put a limit to an enumeration that might become wearisome, I shall mention the opinion of Mr. Meisel, who connects the mysterious fact with optical phenomena developed in the atmosphere of Mars. According to him, the vapor emanating from the canals and assuming above them, without, however, our seeing why, the form of a clearly defined half cylinder, may, in certain cases, lead to the duplication of the images that reach us.

In a very recent publication Mr. Norman Lockyer attributes the dividing of two Martial seas to rows of clouds placed, or rather placing themselves, longitudinally along the center of the surface of the water.

This series of tentatives suffices, I think, to show that the question is not one of the easiest to solve, and the remark diminishes by so much my scruples to attack, after so many others, a problem that has for ten years been declared insoluble.

And yet it seems to me that the explanation is most simple, my opinion being based not only upon a reasoning that appears to me valid, but upon experiments that immediately give an artificial reproduction of the gemination.

This reproduction, of which the accompanying figures give an idea, takes place under conditions such that one may even ask himself how, instead of being surprised at the natural phenomenon, he had not from the origin foreseen the manifestation of it.

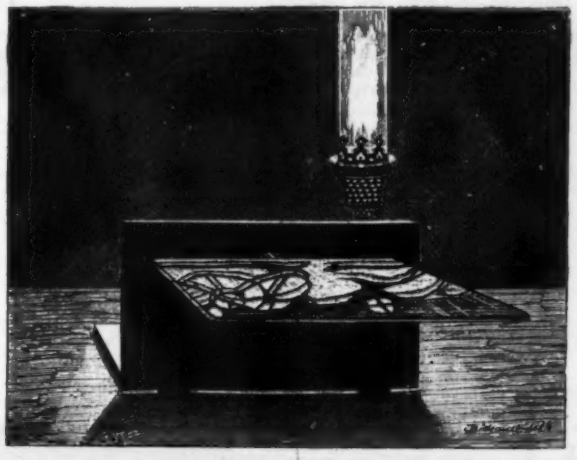


FIG. 1.—ARTIFICIAL IMITATION OF THE GEMINATION OF THE CANALS OF MARS OBTAINED UPON A METALLIC PLATE.

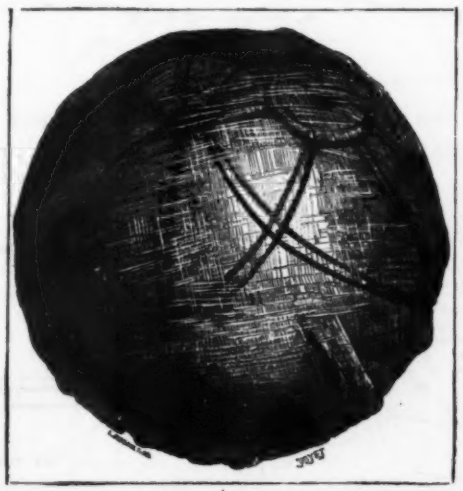


FIG. 2.—ARTIFICIAL IMITATION OF THE GEMINATION OF THE CANALS OF MARS OBTAINED UPON A METALLIC GLOBE.

Upon a polished metallic surface I draw in dead black a series of lines representing more or less accurately the geographical map of Mars, and I let fall upon it a ray of light from the sun or any other luminous source. I then place at a few millimeters from the metallic surface, and parallel with it, a piece of fine and very transparent muslin stretched upon a frame, and I immediately see all the lines and all the spots divide into two, in consequence of the appearance, alongside of each of them, of its shadow delineated upon the muslin by the light that the metal has reflected.

The resemblance of the effect produced to the map, in which Mr. Schiaparelli has synthetized all the geminations observed, is most startling (Fig. 1).

Fig. 2 shows how, in certain cases, the plane mirror of the first experiment has been replaced by a polished metallic sphere upon which the map has been drawn, and which has been covered with a jacket of glass supporting the muslin.

The gemination has produced itself with the aid of this apparatus, just the same as with the first arrangement, and in such a way as to much more resemble the drawings of the natural phenomenon by Messrs. Schiaparelli, Terby, Perrotin and other observers.

It is easy to recognize that all the essential conditions of these experiments are realized on the surface of Mars and its atmosphere. The solar light striking the planetary disk is reflected very unequally, according to the points; much by the continents, and much less by the dark surfaces, seas and canals. When the atmosphere of the planet is limpid, the inequality in question is not sensible; but if the aerial ocean contains a stratum of transparent fog at a proper height and with a proper opalescence, the contrast appears therein as upon the muslin, through the production of shadows, which, to an eye placed elsewhere than upon the prolongation of the reflected rays, reproduce alongside of each of the but slightly reflecting surfaces an image like it.

This phenomenon of shadows by reflection cannot be exclusively proper to Mars; it must be developed upon the earth and upon Venus, but it is only with regard to Mars that we are well placed for observing it. It could not be developed upon the moon, on account of the absence of an atmosphere, and, conversely, its absence may be counted as a new proof of the disappearance of a gaseous envelope around our satellite.

Mr. Schiaparelli has noted that at the time of the gemination the two conjugate canals are not always parallel, and that certain canals are divided into two only in a portion of their length, etc. All such peculiarities and many others explain themselves by the irregularity of the stratum of nebulosities, which may be imitated by undulating the muslin, this bringing about comparable modifications. The very great variations in the interval between the two terms of the same gemination are explained in the same way by the very variable height of the stratum on which the shadow may be delineated and by the large or small angle at which we observe the phenomenon.

Finally, the displacement even of the canals that has been noted may be connected with the unequal refractions caused by the aerial vapors.

It may be asked why the gemination seems exclusive to the canals and other narrow accidents, and is scarcely perceived upon the seas. Experiment answers the question by showing that the shadow of the wide spots simply displaces their edge and produces therein a zone of a different black. Many of the marblings of the seas observed directly upon Mars are doubtless explainable in the same way.

In the special case of a reflecting sphere we find that the spacing in each gemination varies with different conditions, the principal of which are the angle of incidence of the light of the sun, the situation of the geminated canal with respect to the center of the planetary disk, and, finally, the height above the surface of the nebulous stratum that arrests the shadow. With certain relative positions of the sphere and luminous focus it is easy to see that the maximum spacing, all things otherwise equal, is produced toward the center of the disk, this being conformable to the fact more than once observed directly upon Mars.

The principal interest of these remarks appears especially to be the permitting of an unanswerable test of the hypothesis proposed. If, as I think, the gemination results from the phenomenon of reflection that occupies us, we may foresee in each case on what side of a given canal its shadow will be produced, and it is unnecessary to say that if the result of the test is unfavorable, I will be the first to abandon an opinion that has seemed to me plausible, but which can be definitely admitted only after demonstration.

It results from my experiments that the nebulous stratum upon which the shadow is delineated may be found at extremely diverse heights above the curved mirror without leading to any other modifications in the effect produced than variations in intensity and spacing, which may be more or less neutralized, however, by changes in the position of the sun.

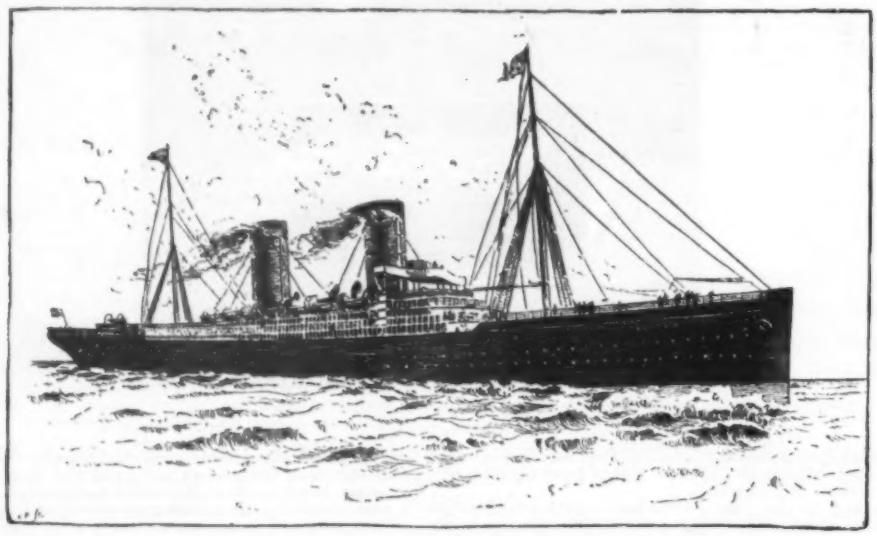
Another necessary remark concerns the state of the reflecting surface, plane or spherical, employed in the experiments. The reason that I have had recourse to metallic plates and globes is to render the phenomenon very visible in order to be able to obtain photo-

graphs of it; but it is possible to use a simple sheet of white paper as a reflecting surface. The gemination is produced in a piece of muslin placed over it. Hence the consequence that it must not be concluded from the production of the shadows reflected in the atmosphere of Mars that the image of the sun should be delineated upon the planet as in a mirror.

I shall add, in conclusion, that the extraordinary simplicity of the explanation that I propose of the phenomenon of gemination would put me on guard against it, after the innumerable efforts that have been made to find it, if the experimental test to which I have submitted it did not appear decisive in its favor. —*Stanislas Meunier, in La Nature.*

THE NEW STEAMERS OF THE CUNARD LINE.

THE Campania and the Lucania are sister ships, the latter quite recently launched, and both are rapidly nearing completion. They are the most recent and probably the best examples of naval architecture now afloat. Length, 620 ft.; breadth, 65 ft. 3 in.; depth, 43 ft.; displacement, 18,000 tons; indicated 15,000 horse power, twin screws, 12 double ended boilers, 96 furnaces. Funnels 21 ft. diameter, 120 ft. high. These boats are expected to maintain a speed of 22 knots per hour, and make the Atlantic trip in five days.



THE NEW CUNARD STEAMER LUCANIA.

THE SIMPLEX AND HUGE TORPEDOES.

By H. C. VOGT, Copenhagen.

ALTHOUGH it is absurd to deny the supremacy of artillery as a destructive agency, there are, nevertheless, some few cases where its use can only be explained as a result of the force of tradition. Let it, for example, as a singular case, be required to sink an enormous ironclad without any crew on board; 500 lb of dynamite brought to explosion close upon her finishes this task in a few minutes, whereas it takes much longer time, expense, and trouble to shoot her down. The effect of a ram blow is similar to that of a torpedo, but requires the apparatus of a strong ship. Formerly two line-of-battle ships could shoot for many hours without destruction to any of the fighting parties, although the guns brought into action were more numerous than when two ironclads are engaged. Moreover, the shots of yore, though of smaller absolute energy, had a greater penetrative power in proportion to the wooden walls than the shots at present in proportion to the iron walls. It is most difficult to hit the water line; balls sent in that direction generally ricochet along the water, with a fair chance of hitting the enemy's hull, but a modern long-shaped shell shot ricochets in a direction after the clouds.

Let us now consider a crew on board the said enormous ironclad which should be sunk; it is there difficult to apply a torpedo, and much more so to apply a ram, on account of the lack of maneuvering power of the larger ship. Suppose a man approaching with a torpedo boat; if he is bold and goes near enough, his feeble craft will have so many holes that it is sure to go down, but if the arrangements are such that the boat itself has the explosive substance in its bow, it can continue its course toward the ironclad without stoppage or delay of any kind, hit the ironclad and thus sink it—preparations being made for the crew to leave the explosive boat in due time. The time interval from crew leaving until hitting will only be about twenty seconds, in which time it is impossible to shoot it down. It is this method which is followed out in the two torpodoes shown in the accompanying illustrations. The first of these—the Simplex torpedo—has already been presented to the British, the American, and the Danish governments, without finding favor; but on account of its connection with the *new proposal*—the Huge torpedo—which follows, a portion of the article on it which appeared in a former number of the *Steamship* is reproduced, together with the criticisms which the United States Navy Department was kind enough to give upon it:

THE SIMPLEX TORPEDO.

If reason could be imbibed into an automatic torpedo, the state of ironclads would be less safe; now, however, an automatic torpedo may not only fail on account of its own complications and those of its gun and boat, but its course in the water is also unreliable as long as it is not directly led. Suppose the probability to hit a mark with a torpedo boat (if permitted to ram) to be $\frac{1}{b}$, and with the torpedo itself $\frac{1}{p}$, then the probability of hitting with a complex system, consisting of torpedo boat and torpedo, is $c \times \frac{1}{b} \times \frac{1}{p}$, where c is a coefficient and — the aim supposed to be taken with the torpedo boat from which the torpedo is launched.

Almost universally $\frac{1}{b} > \frac{1}{p}$, even if the vessels are not quite similar, because it can be proved that the angles turned, in the same time, with similar vessels, *having the same speed*, are inversely proportional to the *second powers of their lineal similar dimensions*; besides this, the maneuvering power increases almost directly with the speed. The mathematical proof for this is the following: In the formula—

$$I(w - w_0) = \int_0^t M\,dt,$$

I denotes the moment of inertia of a ship round its instantaneous vertical axis of gyration, w and w_0 are the angular velocities, M is the moment of the water resistance, dt the time differential. Now, let I_1, w_1 and w_2, M_1 and t_1 denote the corresponding quantities for a similar ship, then we have, using the formula in a practical manner:

$$\frac{I(w - w_0)}{I_1(w_1 - w_2)} = \frac{M\ t}{M_1\ t_1}$$

Here it must be remembered that the said moments of inertia are proportional to the fifth power of the dimensions, whereas the moments of the water resistance are proportional to the third power of the dimensions when the ships have the same speed. Suppose the dimensions of one ship to be n times those of the other, then $\frac{I}{I_1} = n^5$, whereas $\frac{M}{M_1} = n^3$. Introducing this into the formula we get, during the interval of equal times, or $t = t_1$,

$$n^2 \frac{w - w_0}{w_1 - w_2} = n^3, \text{ or}$$

$$\frac{w_1 - w_2}{w - w_0} = n^2;$$

from which it will be seen that the angles turned are inversely proportional to the square of the dimensions. Also, in accordance with this law, the powers with which similar ships, with equal speeds, maintain their courses are proportional to the second powers of their lineal dimensions.

From what has already been said, it becomes clear that a Simplex system, where torpedo and torpedo boat are comprised in one body, would be the most efficient. The accompanying illustration shows a Simplex torpedo intended to be led by a man until, say 500 ft. from the ship to be destroyed, he drops himself into the water in a particular dress or swimming apparatus. A torpedo led in this manner cannot very well miss its mark. The outer appearance of a Simplex torpedo is similar to a Whitehead torpedo furnished with a slender superstructure to keep the torpedo on a fixed water line. The side view of the torpedo is given in Fig. 1; a section is shown in Fig. 2, and a top view in Fig. 3. The water plane area of this Simplex torpedo should be as small as possible to prevent pitching, because that motion, as known from the Whitehead torpedo, does also cause horizontal deviations. The superstructure, S, should be made up of light material to preserve its buoyancy when damaged by shots; at the afterpart of the superstructure is the breakwater, B, furnished with a small window. The master of the torpedo sits in this hollow breakwater, which should be strong enough to protect him from small shots; the visible part of the Simplex torpedo being thirty times smaller than that of an ordinary torpedo boat, the chances for destroying it are of course as many times smaller. The swimming apparatus with which the said master is covered is more properly a swimming boat, which fits the trunk and is furnished with four bags with webs at their tips; arms and legs should be put into those bags, to use the webs. In an ordinary swimming dress it is not possible to obtain a speed of over 1·5 knot, but in a swimming boat the speed ought to be as in ordinary small boats. The engine in the Simplex torpedo might be similar to that in the Whitehead torpedo, but the steam boiler should contemporaneously serve as a reservoir for power, and must therefore be able to stand a very high pressure. The fuel should require no attention for some hours; petroleum must therefore be burnt in apparatus suitable for that purpose. Everything should in fact be prepared at the station, or ship, to which the Simplex torpedo is attached, so that only helm and maneuvers are left to the master. In case the Simplex torpedo is sent against a ship at anchor, a small torpedo, O, is furnished to break the net. In approaching the enemy the small surface of the Simplex torpedo is of course an enormous gain compared with the big size of an ordinary torpedo boat, but the superior maneuvering power resulting from its smallness is perhaps a still greater advantage. The speed should be in accordance with the laws for corresponding speeds, with the Whitehead torpedo as a unit.

The criticism given upon the Simplex torpedo by the United States Navy Department was the following:

1. Dependence is placed upon a boiler and machinery that, having been left unattended during the time occupied in approaching the enemy (which may be hours), is then expected to develop greatest power at the moment of attack.

2. Making a considerable change in the trim of the boat at the critical moment of active service, probably causing a serious deflection of her course in the remaining distance to be run.

Moreover, the whole design was not considered sufficiently developed and reliable in service, etc.

THE HUGE TORPEDO.

The new proposal consists, as will be readily understood from the accompanying illustration, in an explosive boat—the Huge torpedo—with dynamite in its bow, and furnished with a slope aft, whereon there is a refuge boat, in which the crew, engineer, and leader take their place when going to attack. The Huge torpedo approaches in this state toward the ironclad, but, 600 ft. from it, a powerful spring is released, which at once launches the refuge boat into the sea. Compressed air may also be used in launching the refuge boat. The refuge boat may be driven further off by means of oars, or by a small propeller and machinery (similar to those of the White-

FIG. 1. FIG. 2.

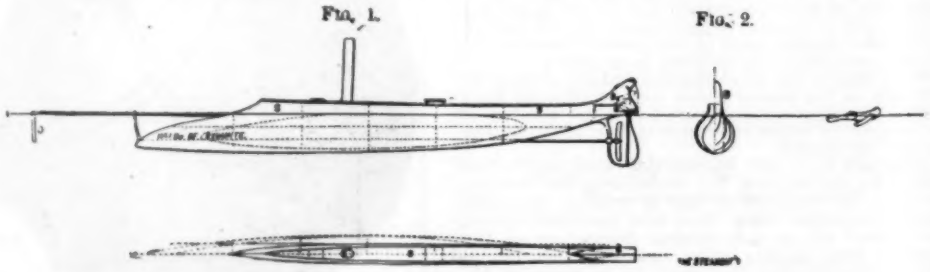
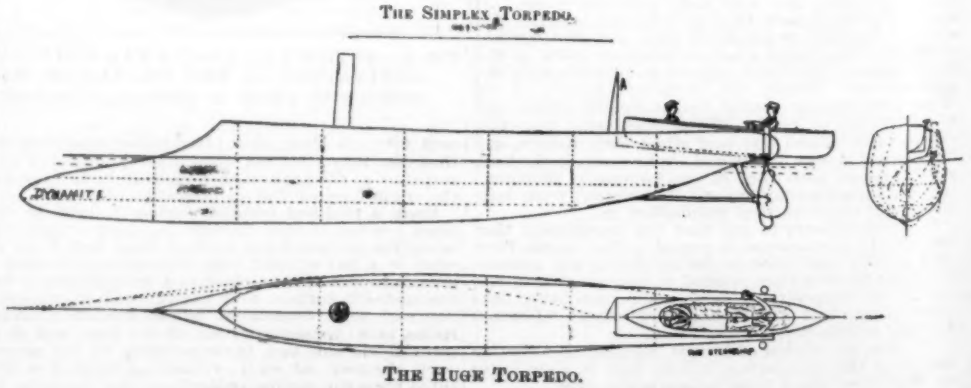


FIG. 3.

THE SIMPLEX TORPEDO.



THE HUGE TORPEDO.

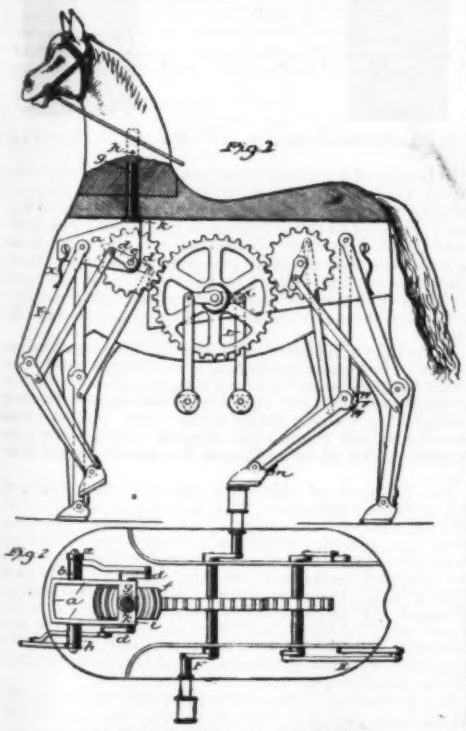
THE SIMPLEX AND HUGE TORPEDOES.

head torpedo), which could bring it some thousands of feet off in a short time. The refuge boat is protected by a small shield (marked A in the illustration) as long as it stands on the Huge torpedo. A large torpedo keeps its course better than a smaller one. The mathematical reason for this is given under the Simplex torpedo. The Huge torpedo, if properly led, cannot therefore very well miss its mark, and if it did, its course is continued for some distance, whereafter it, if not shot down, can be manned again. The stem of the Huge torpedo, and the plates adjoining it, should be so strong that they, without causing leakage at the bow, should be able to cut asunder strong nets, beams, and the like, intended to hinder its progress. The stem is also of peculiar shape, intended for being pressed over or under rafts or the like put out for the protection of the ironclad. The dynamite is only brought to explosion when the bow of the Huge torpedo is caused to leak, so that the water, penetrating, ignites the calium and thus enforces an explosion, by this or any other of the ordinary means (more of these means could also be used at once). The bow is, of course, perfectly smashed when hitting the ironclad with a high speed. *The simplicity of the Huge torpedo is one of its chief features: the enthusiasm and intellectual energy of its leader are not hampered by any complications.* Most people would reason like this: It is much cheaper to use an ordinary Whitehead torpedo sent from an ordinary torpedo boat. But the case is this: *When an ordinary torpedo boat approaches an ironclad, it will be pierced by so many shots that it is sure to sink within five minutes, and the torpedo sent from it may be caught by a net, so that the result is nothing!* But when a Huge torpedo approaches, going over 1,700 ft. in a minute (no stoppage or delay being required), any number of shots *cannot sink it in that time.* Ordinary torpedo boats, when built with a slope aft for a refuge boat, etc., can easily be transformed for being used both as ordinary torpedo boats and as Huge torpedoes.

Referring to the second objection used by the United States Navy Department in the case of the Simplex torpedo, it is quite true that the Simplex torpedo, and consequently also the Huge torpedo, will have one (although insignificant) tendency to deviate either to the one or the other side, according to the nature of the propeller, as soon as the refuge boat is launched; but it is a very simple matter to counteract this with the helm, which also automatically should turn a little when the launching takes place. There are no more difficulties with the Huge torpedo than that any contractor, who has the ability to construct an ordinary torpedo boat, easily designs or alters an ordinary torpedo boat into a Huge torpedo.

A MECHANICAL HORSE.

THE recently patented invention of Lewis A. Rygg, of St. Paul, Minn., has for its object to provide a mechanical horse of convenient size for a person to ride



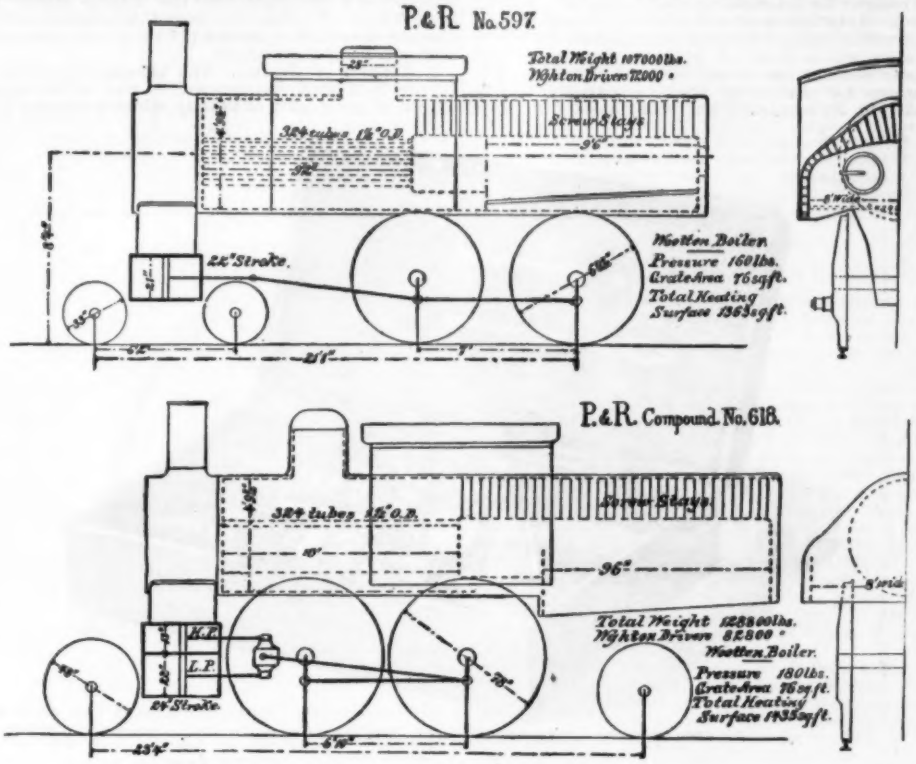
A MECHANICAL HORSE.

on, and of such construction that the rider may operate the horse with his feet, causing it to walk, guiding it, etc. The cranks are adapted to be operated by the feet of the rider in the manner usual for riding bicycles by stepping on the crank pin or a block provided thereon.

The front legs are pivoted to a separate frame or hood, *a*, to studs, *b*, *b*, provided upon said hood, and are operated by the cranks, *d*, *d*, fixed upon the ends of the shaft, *e*, that is journaled in the said hood and at its middle has a gear wheel, *f*, secured to it which meshes with and is operated by the main gear wheel, D. The hood, *a*, is provided with a round stem, *g*, that extends upward through and is journaled in the block, B. The upper end of said stem, *g*, is secured by a pin *h*, in the neck piece, *i*, which is otherwise loosely mounted upon the front part of the horse, so that the operator by taking hold of the reins, *j*, may turn the head of the horse and thereby the hood, *a*, and front legs, Y, Z, to the right or left as may be desired, to direct the motion of the horse. The gear wheel, *f*, is made thick enough to prevent its disengagement with the gear wheel, D, when it is swung to either side together with the hood, and in order to make its swinging more easy, the face of the said wheel, *f*, is crowned to a circle, having its center in the center line of the stem, *g*.

All four of the horse's feet are provided with hoofs pivoted to the lower ends of the bars. The bottom portions of said hoofs are made of rubber in order to prevent the horse from slipping; said rubber also prevents jars and jerks to the rider, caused by the steps of the horse; for the latter purpose I also provide upon the back of the horse a suitable spring saddle for the rider to sit on.

In operation the rider takes his seat on the back of the horse or on a saddle placed thereon, places his feet in the stirrups or treadles and operates the main wheel, D, whereby the wheels, P and *f*, and all four of the horse's feet are operated. In the meantime he guides the horse by turning its head and front legs to either side as described.



RECENT HIGH SPEED LOCOMOTIVES.

RECENT HIGH SPEED LOCOMOTIVES.

DURING the last few years there has been such an increase in the size and weight of passenger trains that locomotives formerly regarded as first class are now entirely inadequate to do the work required of them. The ever-present demand of the public to travel faster has made it necessary to construct larger and more powerful engines, until now we have train loads of nearly 400 tons moved at an average speed of over 50 miles an hour in regular service.

Ten years ago there were only a few railroads using passenger engines heavier than 43 tons. To-day a 50 ton machine is all but universal, and where the duty is severe, engines weighing as much as 66 tons are used. It must be understood that these remarks apply to high-speed, long-distance passenger service only. The accompanying diagrams show four locomotives regularly employed in such service, with their leading dimensions. An idea can thus be formed of the types that are proving most serviceable to-day, and while not by any means the only ones capable of such performances, are nevertheless representative types.

Of these four, two are compound locomotives, built on the Vauclain system, with four cylinders; two piston rods on each side of the engine actuating one crosshead. One of the compounds is also interesting on account of the location of the driving wheels, involving the use of a return side rod. This is rather new in high speed passenger engines, and in connection with leading and trailing two-wheel trucks, is said to confer great stability at high speeds. The other compound, No. 385, Central R.R. of New Jersey, has made a record recently by pulling a train of four cars at the rate of 97·3 miles an hour for several miles, and quite frequently covers a part of the run at over 80 miles an hour. This engine, in connection with the two Reading engines, Nos. 597 and 618, hauls the "Blue Line" express trains between Jersey City and Philadelphia.

On the New York Central, No. 903 takes the "Empire State" express, New York to Albany, 143 miles in 2 hours 45 minutes. The regularity with which the fast service on these roads is performed is good evidence of the success of these locomotives.

REGINALD GORDON.

THE MANUFACTURE OF LIQUORS AND PRESERVES.*

By J. DE BREVANS, Chief Chemist of the Municipal Laboratory of Paris.

PART IV.—CHAPTER I.—*Continued.*

IN 85° (Gay-Lussac) alcohol the examination to see if the rectification has been properly carried on is conducted as follows: 1. Tasting gives very good results for this trial. But as this requires long experience, other methods must be used.

2. M. Savalle has devised the following process, which is one of the best. Monohydrated sulphuric acid is a good reagent for determining the degree of purity of alcohol. Sulphuric acid, which should be colorless, is boiled with an equal volume of pure alcohol. Very little coloration will be observed, while the less the alcohol has been rectified the deeper becomes the tint. The apparatus for measuring the transparency of the liquid (Fig. 57) consists of ten color glasses, varying in color according to the degree of purity of the alcohol. These serve for types of comparison for the tests. The test is conducted as follows: 10 c. c. of alcohol are placed in a small flask and an equal quantity of sulphuric acid (c. p.) is added. The mixture is shaken and heated to boiling (Fig. 58). The source of heat is then removed and the liquid is poured into a white glass flask or test tube and a comparison is made with the test glasses. By this comparison the degree of the impurity can be told at a glance.

FIG. 57.—DIAPHOMETER OF SAVELLE.

FIG. 58.—TEST OF ALCOHOL BY HEAT.

The test for aldehyde is made with bisulphite of rosaniline, which is prepared in the following way:

Solution of fuchsine, 1-100	125 c. c.
Solution of sodium bisulphite at 30°..	75 c. c.
Solution of sulphuric acid, 1-10	250 c. c.
Water, q. s. to make the volume.....	1 l.

When a certain quantity of the reagent is added to the alcohol, after some minutes a violet red coloration will be seen, varying with the quantity of the aldehyde. Absolute alcohol gives no color. An ammoniacal solution of silver nitrate can also be used, which will be reduced in the presence of the aldehydes.

SECTION II.—BRANDY.

The analysis of brandy comprises: 1, the amount of alcohol; 2, the amount of extract; 3, the amount of acidity; 4, adulterations.

1. Amount of Alcohol.—This cannot be determined directly, as with alcohol, for the brandy is often charged with extractive matter obtained from the vessel in which it is preserved or added to render it proper for consumption. It is necessary to redistill to separate the alcohol. The brandy is diluted with its volume of water and is distilled in the apparatus of Salleron (Fig. 59), which receives the liquid which is condensed in a gauged vessel, and the operation of the still is stopped when the volume of distilled liquid has attained the half of the liquid which was submitted to trial. The strength can then be taken as directed for alcohol.

2. Amount of Extract.—The quantity of extract contained in natural brandy is almost nothing. In reality it is composed of the materials which the alcohol in the brandy may have dissolved in the vessels in which it has been preserved, for in general brandy is kept in casks, so that tannin and some saline materials are frequently found. The amount of extractive matter is determined in the following manner:

A known quantity of brandy is placed in a capsule of platinum, glass or porcelain. The capsule is placed on a stove heated to 100° or above in a water bath, the desiccation is prolonged until the volatile matter has been driven off, when the capsule is weighed and the amount of extractive matter per 100 c. c. (or more often a liter) is easily determined.

3. Amount of Acidity.—The amount of acidity of brandy is of prime importance, in view of the appreciation of the quality of brandy, which is assured if the liquor is prepared from a wine of good mixture, without having been submitted to acetic fermentation. The operation is very simple. In a trial glass place a known volume of brandy, 10 c. c. for example, with four or five times its volume of distilled water, and determine the acidity by means of a solution of potassium, using phthalein, phenol or litmus as indicator. Acidity is expressed in general in analyses by sulphuric acid.

4. Examination for Adulterations.—A large part of the 85° (Gay-Lussac) is consumed under the name of brandy, from wine, cognac, rum, kirsch, etc., after having been diluted with water and by the addition of various aromatic substances known under the name of sauces or bouquets, added to give a little perfume to the natural product. Brandy thus prepared is colored with caramel or cachou.

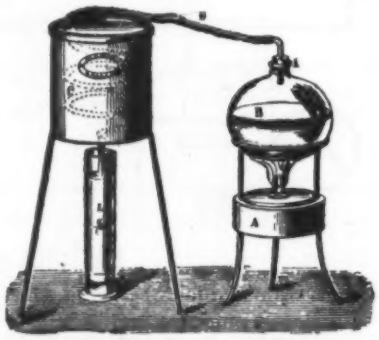


FIG. 59.—STILL OF SALLERON.

The natural products are themselves submitted to certain operations which have for their end the aging of the product. One method is to add a few drops of ammonia to each liter or a few grammes of sugar. The tasting of brandy by a taster who has had long experience is the best means of determining the value of brandy. Alcohol made from amylaceous materials, beets, potatoes, etc., often contains, by reason of incomplete rectification, alcohols homologous with alcohol from wine. Separate and mix the suspected alcohol with its volume of ether, then twice its volume of water. The ether then separates, carrying the foreign alcohols, which can be determined after the slow evaporation of the solvent. This method of procedure permits the amyl alcohol to be saved.

For methyl alcohol different methods must be employed, the most simple being that of MM. Cazeneuve and Cosson, which shows that impure methyl alcohol is instantly decolorized by potassium permanganate, while ethyl alcohol is only reduced at the end of a long time. The brandy is distilled to remove the sugar and the caramel, which equally reduces the permanganate of potassium. The first tenth part which is distilled is used for the test with the permanganate.

M. Reynolds recommends the following process: In the distilled alcohol, which has been brought up to about 50 per cent., a few drops of a weak solution of bichloride of mercury is added and then an excess of potassium in pure ethyl alcohol. The precipitate is yellow and flocculent. If the alcohol contains only 10 per cent. of methyl alcohol, the precipitate will be white and not a great deal of it. This precipitate is dissolved by heat.

SECTION III.—SWEET LIQUORS.

The analysis of liquors comprises:

1. The Amount of Alcohol.—This is determined in the same manner as directed for brandy.

2. Amount of Sugar.—This test is easily made by means of the cupro-potassium solution of Fehling.* To make the test take exactly 10 c. c. of the solution, add 90 c. c. of water. Then transform the cane sugar to inverted sugar by heating over water bath with 10 per cent. of hydrochoric acid. The inversion requires about a quarter of an hour.

When the liquid is cold it is brought up to its original volume with water. It is then treated with animal black to decolorize it. After some hours of repose, filter. The liquid, after filtering, should be perfectly colorless. Dilute anew and test for the total amount of sugar contained in the sample.

To test for sugar, put in a capsule of porcelain or in a flask an exactly measured quantity of the Fehling solution. Then, after having diluted it, the mixture is carried to the boiling point, the liquid is let fall drop by drop, with the aid of a burette divided (Figs. 60 and 61)

FIG. 60.—BURETTE.

FIG. 61.—BURETTE.

into tenths of a cubic centimeter, into the sugar. The liquid is decolorized and diluted until the copper is completely precipitated in the form of red oxide of copper. The end of the operation is indicated by the complete decolorization of the top layer, which now has the look of pure water. If it preserves a blue tint, the reduction is not finished; if, on the other hand, the liquid becomes yellow, an excess of sugar must have been used, as the tint is due to the action of the potassium on the sugar.

3. Test for Glucose and Dextrine.—Glucose is found normally in liquors called fancy, and in this case is perfectly legitimate, but a large number of liquor manufacturers also employ dextrine (British gum) in their liquors, it is said, to make them more mellow. This practice is bad, commercial glucose being rarely pure enough, and it gives to liquors a distinctive taste of its own.

The presence of glucose in liquors is determined in the following manner. The amount of sugar before and after inversion is determined. The first operation gives us a quantity of naturally inverted sugar existing in solution always very weak in liquors prepared with the juice of fruits, and the glucose which may have been added. The second test gives the total amount of sugar. If the quantity of sugar which reduces the liquor of Fehling without previous inversion is considerable, relative to the total quantity of sugar, the presence of sugar is certain. This can be determined by the polariscope.

In a polariscope tube of 22 centimeters various liquors which have served in the test of sugars are successively introduced. If the two liquors deflect the ray of polarized light to the right, the presence of glucose is assured, for the sugar deviates constantly to the right with polarized light, while the sugar which has been inverted and the sugar of fruits give a deviation to the left. To determine exactly the different elements which enter into a mixture of sugars will be given farther on in treating of the analysis of simple sirups.

Dextrine is also easy to determine by a process called dialysis, founded on the property possessed by sugars of passing through membranes, such as parchment, etc., while dextrine is retained by it.

FIG. 62.—DRUM OF DIALYZER.

In the drum of a dialyzer (Fig. 62) place a sufficient

* Sulphate of copper cryst..... 34.639 grms. in 500 c. c. of water.
Rochelle salts..... 173 " " 400 " "
Sodic hydrate..... 50 " " 100 " "

Keep the sulphate of copper solution in one flask, the other in another. Mix as wanted for use.

* Continued from page 14353, SUPPLEMENT, No. 896.

quantity of liquid, say 100 to 200 c. c., and the instrument is placed in a vessel as represented in Fig. 63, the water in the vessel being constantly renewed. After some days, when all trace of sugar has disappeared, the

FIG. 63.—DIALYZER.

liquid of the dialyzer is concentrated over a water bath to a sirupy consistence.

The sirup is then thrown in two or three times its volume of absolute alcohol, which precipitates the dextrine in the form of white flocculent matter. This is gathered on a filter, washed several times with alcohol and is dissolved with the aid of heat. This solution then serves for a trial solution for testing for dextrine. With the polariscope the light turns to the right. The presence of dextrine in small quantity in a liquor is generally the indication of the presence of glucose. This sugar is nearly always present, above all in liquors prepared from amylaceous materials saccharified by diastase.

Another indication of the employment of glucose is furnished by the presence of calcium sulphate in liquors, which is employed to saturate the excess of sulphuric acid which served to saccharify the first materials.

The presence of salt in the ash is determined by the calcination of the extractive matter of liquors. The mineral matter so obtained is dissolved in weak hydrochloric acid, and is then treated with barium chloride; if a precipitate is the result, the presence of the sulphate will be proved.

4. Examination for Saccharine.—This is treated in speaking of the analysis of sirups farther on.

5. Examination for Essences and their Approximate Amount.—A large amount of the essences contained in a liquor can be extracted in the following manner: A sufficient quantity of liquor, say 100 c. c., for example, is diluted with its volume of water, or with one and one-half times its volume, according to its alcoholic strength. The solution is agitated with ether in a decantation beaker. When, after repose, the solvent is separated by decantation, the ethereal solution is filtered and allowed to freely evaporate, or is placed in a vacuum. The extract which is obtained is composed of essences taken from the liquor by the ether, which permits of its value being estimated. If the operation has been made with exactly measured volumes, the weight of the extract obtained by the evaporation of the ether in the vacuum gives very approximately, it is true, the total quantity of essences which were used in the preparation of the liquor which was analyzed.

6. Examination for Coloring Matters.—As has already been seen, a certain number of coloring materials are permitted in the preparation of liquors. The examination for injurious colors, especially the anilines, is more in the province of the chemist than in that of the liquor manufacturers.

7. Liquors which Contain no Sugar.—The analysis of liquors which contain no sugar, as absinthe, is done in the same manner as of those which contain sugar. Its chief interests rests in determining the amount of the extractive matter, which determines whether the liquor was made by means of essences or infusions.

CHAPTER II.

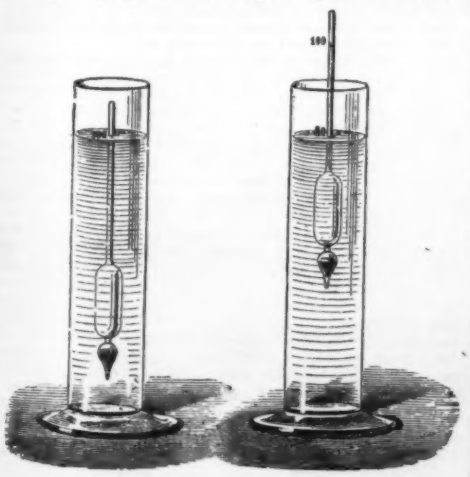
Analysis of Sugar and Sirups.

For determining sugar three methods may be employed:

1. That of Fehling.
2. By means of the specific gravity.
3. By the optical method.

1. The first method has already been described.

2. This method is only applicable to solutions of pure sugar. The density is determined by means of the areometer, which is called in this case the saccharometer (Figs. 64 and 65); this gives directly the



In Pure Water. In a liquid of 1·25 Specific Gravity.

FIGS. 64 AND 65.—HYDROMETERS FOR LIQUIDS HEAVIER THAN WATER.

strength. When the ordinary areometer is used, special tables must be used to give the result.

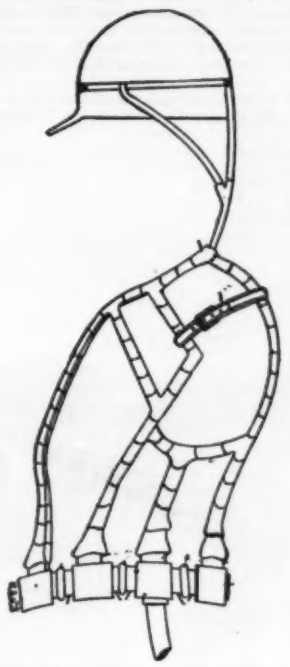
3. Estimation of Sugar by Means of the Optical Method.—This method is founded on the action of solutions of sugar on polarized light, which is measured by means of the polariscope, and for full information on this subject the reader is referred to Tuckey's or Weichmann's works on sugar analysis.

THE END.

THE CAR AND CAB DRIVERS' HEATER.

THIS is a newly patented invention by Robert Henry Yeoman, of Omaha, Nebraska. The coat or jacket consists of a hollow metallic belt, put together with ball and socket joints, as shown. It can be readily put on and taken off by the wearer. Connected to the belt are the distributing branches, preferably made of metal tubing and put together with ball and socket joints in small sections, but they can be made of rubber or other analogous hollow substance, their function being to convey heat to the body of the wearer.

The branch running up the back of the head is adapted to keep the head and ears warm. Other



branches may be added to protect the lower limbs if desirable.

The belt is connected by the hollow tube with a suitable heating apparatus placed under the driver's seat and the coat or jacket can be worn by the driver or traveler.

The inventor says:

There are any number of ways in which the apparatus may be fixed to protect persons exposed to the cold weather. The object of the invention is to supply warm oxygen to the body in preference to air which has passed through fire and had the oxygen taken out.

He claims:

1. In combination with a suitable heating apparatus, the jacket or coat, consisting of a flexibly jointed metallic belt having extending from it suitable branches, said branches and belt being hollow, and a suitable hollow connection between the belt and heating apparatus, the said coat or jacket adapted to impart heat to the body of the wearer, substantially as shown and described.

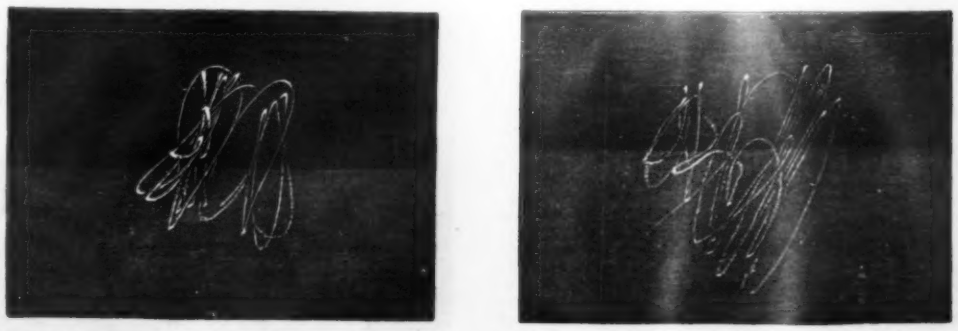
2. In combination with a suitable heating apparatus, the jacket or coat, consisting of a flexibly jointed metallic hollow belt having extending from it suitable hollow branches, said belt also being provided with the parts 2, having the inwardly extending recesses, the said belt being connected by a hollow tube with the heating apparatus, the said coat or jacket adapted to impart heat to the body of the wearer, substantially as shown and described.

ASTRONOMICAL PHOTOGRAPHY ON SHIPBOARD.

MR. J. CHAUTARD, a very skillful operator of Iquique (Chile) has sent us some curious photographs which we reproduce herewith, and which represent, what would never be guessed without an explanation, curves obtained during an eclipse of the moon. These photographs were taken on board of a ship at sea. The exposure was long. As the rolling motion of the ship displaced the photographic apparatus with respect to the planet, the latter traced upon the negative a sinuous curve that, in a measure, registers the ship's motions. The following is what our correspondent says in sending us the two photographs:

"These are two photographs of the eclipse of the moon of May 11, 1892, and the negatives of which I took on board the Ville de Paris, of the Maritime Company of the Pacific, 21° of north latitude and 38° of longitude. No. 1 was exposed for two minutes at 9 h. 35 m. during the beginning of the eclipse. The oscillations described by the luminous point well mark the different rollings and pitchings of the ship. No. 2 received the same exposure, but a quarter of an hour later on, the eclipse being at its maximum, and the lines therefore being less intense. You will remark also that the pitching being stronger in this second photograph, the horizontal curved lines are more elongated and more frequent than in the other. The displacement of the ship having been greater through the pitching, the interval between the lines is greater too. As for the horizontal division of the photograph, that is due to the phosphorescence of the sea, which was very intense that night. The sky was dark and covered with clouds, and it was with great difficulty that I was able to find at two different times a means of impressing my two plates."

An endeavor has often been made to construct apparatus for registering the rolling motions of ships, and we have already given a specimen of such experiments. Might not photography furnish a solution of the question of apparatus of this kind, through the use of the sun or moon, instead of a view being taken of the horizon, as has hitherto been done. It is an idea that we put forth, and that has been naturally suggested to us by Mr. Chautard's interesting photographs.—*La Nature.*



FIGS. 1 AND 2.—PHOTOGRAPHS OF AN ECLIPSE OF THE MOON, TAKEN ON SHIPBOARD.

BRITISH INDUSTRIES UNDER McKINLEYISM.

THE annual report of the chief of the Bureau of Statistics in the United States for the financial year ending the 30th of June, 1892, which has recently been published, brings up the statistics of the trade between that country and the rest of the world to a comparatively late date, and shows in a more complete and detailed manner than any statements hitherto published what has been the effect of the McKinley act of 1890 upon the commerce between the United States and the outside world. The most striking feature of the report is the enormous excess of exports from the United States over the imports into the country as compared with previous years. In 1891 that excess only amounted to $39,500,000, but in 1892 it rose to about $203,000,000, or about five times as much. In other words, the exports rose from $884,000,000 in 1891 to $1,030,006,000 in 1892, while the total imports fell from $845,000,000 to $827,500,000 in the same years. So far as these figures go they appear to prove in an unmistakable manner that the object of the tariff has been fully realized.

The United Kingdom was, as is generally known, the country specially aimed at by the McKinley tariff, and hence it will not, perhaps, surprise any one to find that in the trade of the United Kingdom there has been a serious falling off, relatively to that of other countries, with the United States markets. The total value of the imports from our own country fell from $194,750,000 in 1891 to $156,250,000 in 1892. The value of the imports received from France, as between the same two years, only fell from $76,500,000 to $68,500,000, and that of Germany from $97,000,000 to $83,000,000; but practically all the countries of Europe show a decrease excepting Italy. What is perhaps of more serious moment to the English manufacturer and merchant is the fact that the percentage of the total imports of the United States received from Great Britain has of late years greatly declined in comparison with the proportion contributed by other European countries. The full extent of this decrease can be indicated by a few figures that are to be found in the report of the Bureau of Statistics. In 1892 European countries, including our own, contributed 47 per cent. of the total imports of the United States, as compared with 61 per cent. in 1860; so that Europe as a whole had in the interval declined in reference to American imports from all countries to the extent of 14 per cent. But the decline in the case of the United Kingdom has been much more serious than this, for while this country contributed about 40 per cent. of the total imports of the United States in 1860, we only furnished 19 per cent. in 1892, or, in other words, we had dropped by about 21 per cent. Within the same period France had dropped from 12·2 per cent. to 8·3 per cent.; while Germany had risen from 5·2 per cent. to 10 per cent. of the total. In reference to other European countries, the difference as between the two periods is too small to call for special remark, but it is proper to observe that the United States are now taking a much larger share of their imports than formerly from South and Central American countries, from Asia and Oceania. On the other hand, Great Britain continues to be by far the most important customer of the United States in reference to the export trade of that country. As between 1891 and 1892, our imports of American produce, as stated in American returns, rose from $441,000,000 to $493,000,000, but this is only what happened—but, of course, in a much less degree—with the trade between the United States and other European countries. In 1892, 48¼ per cent. of all the exports sent out from the United States were received by Great Britain, while France and Germany each received only about 10 per cent. Obviously, therefore, Great Britain continues to be the most satisfactory customer, from an American standpoint, that the United States can claim, our imports

from that country being about 2½ times our exports thereto.

In examining the export returns of the United States for 1892, we are struck with the fact that the increase to which attention has been called has been almost wholly an increase in the products of agriculture. This means that, despite the ambition of the people to become a great manufacturing nation, and to compete with European countries in neutral markets, they have not exported so large a quantity of manufactured goods in 1892 as they did in the previous year. The total official value of the exports of manufactures from the United States in 1892 was $158,000,000, whereas in the previous year it was fully $10,000,000 more. It is only fair to observe that this diminution may be largely attributable to the decline of values which took place all over the world last year. It is possible that the volume of the exports of 1892 may have compared not unfavorably with the volume of the previous year. Whether this is so or not, there is no reason to doubt that the United States, taking a period of years as a basis of comparison, has been making real progress as a manufacturing nation and as an exporter of manufactured goods.

In order that the possible competition to be faced from the United States in future years may be the better appreciated, we have drawn up the following statement of the value of the principal exports from that country of manufactured goods in 1892, compared with the average of the five previous years:

	1892. (£ = $1,000.)	Average of 5 Previous Yrs. (£ = $1,000.)
Cotton manufactured	13,226	12,351
Flax, hemp, and jute	1,998	1,607
India rubber manufactures	1,416	971
Instruments and scientific apparatus	1,388	1,070
Iron and steel	28,800	21,865
Leather and manufactures	12,084	11,296
Musical instruments	1,164	1,033
Paper manufactures	1,382	1,182
Paraffin and paraffin wax	3,965	2,470
Soap	1,063	949
Wood and manufactures of	25,738	24,834

Here we have quite a formidable list of successful manufactures, the most successful of all being iron and steel, in which the Americans are undoubtedly making great headway. Of course, however, the principal productions of American iron and steel works which find a market in other countries are of a more or less special description, and the same remark may be made as to nearly every other article that is exported on a large scale. The time has certainly not yet arrived when American iron works can compete with English on their merits for productions of identical character.

Turning now to the imports into the United States under the McKinley tariff, we find that in the financial year 1892 the principal imports compared as under with the year 1890; that is to say, the first year of the full working of the tariff is compared with the first year previous to its being enacted:

Value of Imports into the United States.

	1890. (£ = $1,000.)	1892. (£ = $1,000.)
Flax, hemp, and jute, unmanufactured	19,844	2,645
Flax, hemp, and jute, manufactured	28,421	26,293
Tin plates, etc	20,298	12,315
Cutlery	2,532	1,207
Sugar, confectionery, etc	89,734	664
Tobacco leaf	17,605	10,332
Woolen manufactures	56,582	35,565
Silk	38,091	28,821

These are the principal differences against foreign markets, but it is at the same time to be observed that there are many items that show a considerable increase in 1892 over 1890, including cement, cotton, cloth, earthenware, glass and glassware, furs, lead manufactures, manufactures of metals, silk clothing, and manufactures in wood. The total amount of decrease in the imports of the principal dutiable articles amounts to $154,225,000, while the total amount of increase in other articles shows the very much smaller sum of $38,000,000. Comparing the same two years, the total decrease in the imports from the United Kingdom amounted to $30,000,000, while the German imports fell off to the extent of $15,000,000, and the French to the extent of $9,000,000. Clearly, then, if we have been hit somewhat hard, we have the poor consolation of knowing that we have not been alone in our misfortune.—*Industries* (*London*).

[Continued from SUPPLEMENT, No. 898, page 14356.]

THE TOUR OF SWITZERLAND.

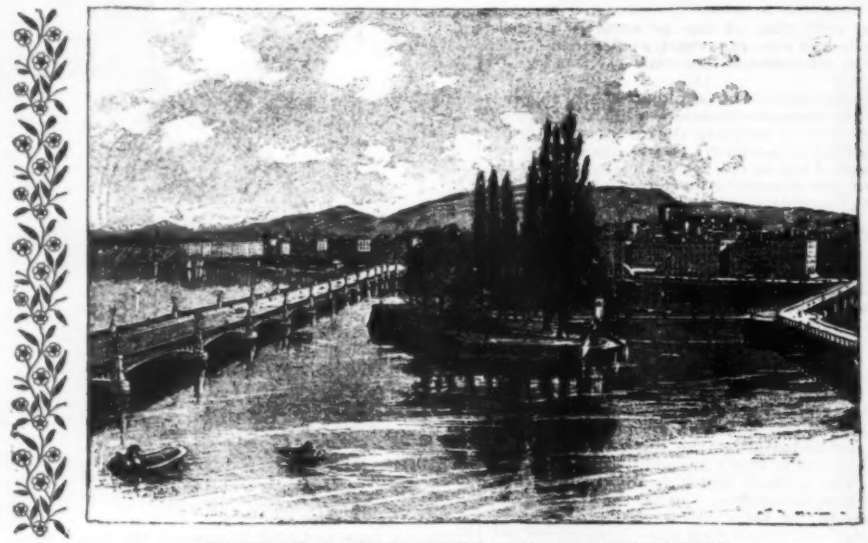
FROM Brigue, as previously stated, there is also regular communication by diligence over the Furka and Oberalp Passes with Chur and thence by rail direct to either Zurich or the Lake of Constance, thus affording the tourist a return trip through southern Switzerland, entirely independent of the route by which he came.

But if he prefer to see Geneva first, let him continue on from Lausanne without change of wagon, and a ride of a little over an hour, passing Morges and Nyon, brings him to the Paris of Switzerland, the city of Rosseau and Calvin, the city of thought and philosophy, the city enriched by memories of scientific development and by the coffers of the Duke of Brunswick.

Geneva is nothing in appearance if not metropolitan. Its long lines of granite quays, ornamented with parks and shade trees and flanked by massive blocks of buildings; its superb and symmetrical bridges, its gorgeous opera house, presented by the late Duke of Brunswick, its Kursaal, its museums, clubs, hotels, restaurants, and cafes all combine to impress upon the visitor that he is in a city which is in the vanguard of modern civilization. A pure French is here spoken and taught, and this fact alone has given Geneva preeminence for centuries as an educational resort for strangers. There is quite a numerous transient population of both Americans and English here, as the existence of an English and an American church testifies. The fame of the city for its manufactures of watches and jewelry is world wide, and an inspection of the numerous establishments in this line will well repay the visitor. And in its surroundings, too, Geneva is especially attractive. What trips by rail, what wondrous sails on the lake, what walks to the Bois de la Batie at the confluence of the Rhone and the Arve, and to the many other charming excursion points around the base of the Saleve Mountain or along the lake shore with the white face of Mont Blanc towering up in the distance, "so near and yet so far." And then a run out to Bellegarde, or Monnetier, a ride up the Voirons to the Dent d'Oche, or the royal trip of all, a day's carriage drive to Chamounix—these are the pleasures which a summer visitor to Geneva may carry away in his memory, to solace him during the daily routine of his home life.

It will of course be borne in mind by the reader, that for tourists entering Switzerland at Geneva, as many English and Americans do, the foregoing description is equally applicable to their trip across the country to Schaffhausen, the various localities being visited in the inverse order to that in which they are here given.

Northward from Geneva to Basle, the line of tourist travel passes the picturesque Lake of Neuchatel, with



VIEW OF GENEVA WITH THE ROUSSEAU ISLE.

the handsome little city of Yverdon (the Roman *Eburodunum*), with its much frequented sulphur baths at its southern extremity, and from which point one may either continue on by rail or change and take steamer to the ancient city of Neuchatel (Neuenburg), which has a history of unusual interest dating from the thirteenth century, and is also celebrated for its charitable establishments, museums, and monuments, and will well repay a day's stay. The view from the environs is superb, extending as far as the city of Berne and including the entire range of the Alps from the Sentis to Mont Blanc.

Bienne and Solothurn are also worth visiting. From the former a funicular road ascends the steep slope of the Jura to the famous watering place Macolin, possessing a remarkably fine climate and view. The latter is, with perhaps one exception, the oldest Cisalpine city extant, and will prove to have a special interest for the classical scholar and the antiquarian.

From Bienne, a ride of three hours brings one to the grand old city of Basle, overlooking the Rhine, where it turns sharply to the north, near the southwesterly limit of the Black Forest. Its geographical position as regards France, Germany, and Switzerland renders it one of the most important of European railway centers, and it is moreover a point of great manufacturing and commercial activity. In its great cathedral, built in the eleventh century, its palace (or Pfalz), its library, its museum, and its mediæval relics, the stranger will find varied and agreeable entertainment, while not the least attraction among the sights of Basle is the view of the Rhine itself from either of the massive bridges here spanning it.

The return route from Basle to Schaffhausen, via Zurich, follows in general the line of the Rhine. At Rheinfelden, half an hour distant from Basle, many visitors are to be found in the summer season, using the salt baths and enjoying the capital fish diet which the falls of the stream at that point afford.

It will interest the reader to know that as many as *a quarter of a million* summer visitors and travelers from all parts of the world are annually estimated to pass over the various routes which have been briefly described in this article. The providing of food and shelter for this immense army of voyagers is a question sufficient to put to a heavy test the talent of any general of commissariat, and it is in this field that the Swiss hotel keeper has earned well won laurels. It is stated that during the summer season 65,000 guests can be lodged overnight at one time in Switzerland, and even lodged comfortably. Go where the stranger may, whether to the grand hotels in the great centers, or to the remotest nooks in mountain resorts, he finds the hotel keeping conducted on a model system of cleanliness, comfort, and punctuality. The service, too, is as a general thing excellent; the Swiss waiter who cannot broil your eggs or bring your coffee in three languages is a rarity indeed.

Nor is it any light task to provide the wherewithal for keeping all these voracious travelers from hunger and thirst during their sojourn here among the Alps. That the appetites engendered by the bracing mountain air are colossal is evidenced by the Swiss customs statistics, which show that the annual importation of wines foots up 3,500,000 francs, of poultry and fresh fish nearly the like sum, of coffee, tea, and sugar, 1,250,000 francs, and so on through all the category of good things, save milk, cheese, and honey, which Switzerland herself produces in the most delicious qualities. To sum it all up, the Swiss boniface is *sui generis*, and is a genius in himself. He gives good accommodation, good fare, good attendance, and gives them courteously and good naturedly withal. In short, not the landlords alone, but *the Swiss people* in general, prove in their intercourse with foreign travelers to be friendly, hospitable, and, all things considered, not exacting in their charges. One must realize what an important item to them this yearly intercourse with strangers—the *Fremden-Verkehr*—is, and how much of the capital, time, and enterprise of the people of the land is centered in it. This fact is rendered especially notable, when one considers the wonderful facilities for travel not only for all classes of people by the main lines of rail and steamer and diligence, but by private conveyance, mule, or small boat, so that there is scarcely an accessible point in the land which a tourist cannot comfortably reach.

And a word here in regard to *Swiss railways*, and

VIEW OF NEUCHATEL.

the admirable manner in which they are conducted. When the nature of the country which they traverse and the enormous numbers of travelers they are called upon to transport during the tourist season are taken into consideration, it must be admitted that the work is done thoroughly and well, both as regards the comfort of the passenger, the punctuality of trains, and the excellent and prompt system of baggage delivery.

Though the *duration* of the Swiss tourist *season* varies a little according to the weather, it may generally be reckoned from early in May to the middle of October, many travelers preferring to enjoy the autumnal beauties of the Alps rather than to linger among them during the heat of the dog days. The land abounds, too, in localities where a mild climate and southern exposure make a winter sojourn desirable. In Davos, Andermatt, St. Moritz, and Maloja, and along the Lake of Geneva and the Italian Swiss lakes, in the vicinity of Lugano and Locarno, are always to be found numerous colonies of winter guests, while in the larger cities like Zurich, Basle, and Geneva all the comforts of metropolitan life may be obtained, to render a residence during the cold months agreeable.

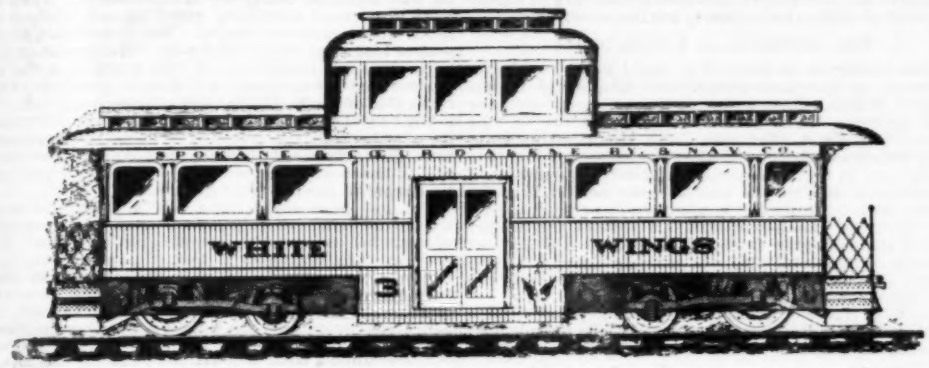
Much has been written in prose and verse, in *history and romance*, concerning the charms of Switzerland for the stranger and the visitor. But no description can convey to a reader's mind the impressions gained by a tour, however brief, through this land of all but ideal beauty, which the facilities of modern travel have rendered easy of access to all the world, and whose liberties and institutions, maintained through ages of heroic resistance to tyranny and oppression, have won for her people the admiration and respect of mankind.

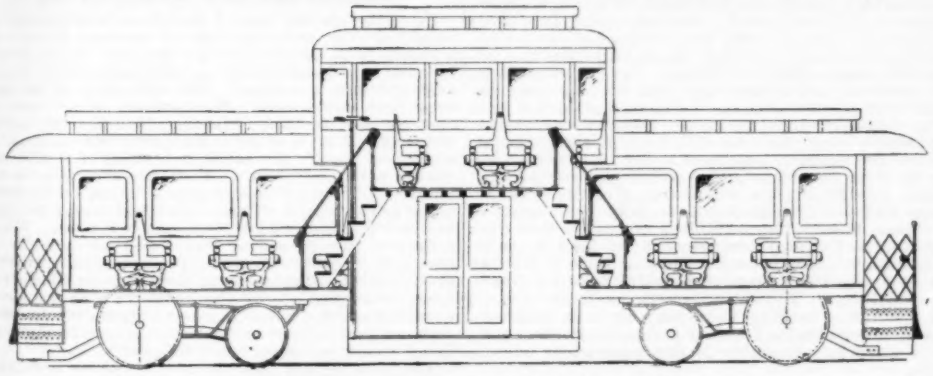
NEW STYLE OF ELECTRIC CAR.

FROM Spokane, Wash., to the beautiful Cœur d'Alene Lake, 32 miles distant, an electric railway will soon be transporting the delighted citizens of that famous city, says the *Street Railway Review*. For use on this road, B. C. Riblet, of Spokane, Wash., the chief engineer of the Spokane & Cœur d'Alene Railway & Navigation Company, has designed a new type of car, and one which is specially well adapted to the work to which it will be assigned. This car, which is about 40 feet in length, will have a seating capacity of 60 persons, with a separate compartment for carrying freight and express, having a capacity 6 × 8 × 9 feet. A speed of 40 miles an hour on levels is contemplated, and will doubtless be attained a good part of the distance, as the grades do not exceed one per cent. and curves are also very light with the exception only of two 10° curves.

Cars will be equipped with air brakes and upholstered with embossed leather, and the windows of plate glass; the entire finish being of palatial character. Outside of the regular passenger and freight business the company will do a big excursion business during the summer months. Trailers will be attached to motor cars to accommodate the traffic at such times. The Cœur d'Alene Lake will be one of the termini of the road. This lake is a very beautiful sheet of water some 30 miles in length, situated in the heart of the Cœur d'Alene mountains, and abounds in fishing and hunting. It is already one of the most popular resorts of Eastern Washington. Our illustrations convey a very intelligent idea of the arrangement of the interior of the car. The observation room will be specially inviting and will also be the location for the motorman. Mr. Riblet has succeeded in planning a car strong in construction, of large carrying capacity and unusually attractive in both interior and exterior.

The driving wheels are 42 inch diameter paper wheels with steel tires. The smaller wheels are 30 inches, of same make. Two 45 horse power single reduction motors will be used on each car. Car and motor equipment will weigh 9 tons. Controlling stands will also be placed on front platform for use in operating car when on that portion of the line within the city. Car will be painted ivory white with gold trimmings. The distance from Spokane to the lake is 32 miles. Power will be derived from two water power stations, one in the city and the other at Post Falls, on the line of the road, 22 miles from Spokane.





RIBLET'S NEW RAILWAY CAR.

ON THE MAGNETIC PROPERTIES OF OXYGEN AT VARIOUS TEMPERATURES.*

By P. CURIE.

THE author states that he has found that the coefficient of magnetization of oxygen is constant for fields varying from 200 to 1,350 C.G.S. units. He has also verified the fact that by varying the pressure from 5 to 30 atmospheres, the coefficient of specific magnetization, with reference to the unit of mass, does not sensibly vary. The ratio of the magnetization coefficients of the same mass of oxygen and water (—145) at 20° C. is $10^6 k_{20} = 115$; the value $(-0{\cdot}79 \times 10^6)$ being taken as the coefficient of magnetization of water, k being the coefficient of specific magnetization of oxygen.

The author carried out two series of temperature determinations. In one set he used a bulb of ordinary glass filled with oxygen at 5 atmospheres pressure. In the other set he used a bulb of hard glass filled with oxygen at 18 atmospheres pressure. This latter bulb was brought without accident to a temperature of 450° C., the pressure being then 45 atmospheres. It was found that the coefficient of variation of k with temperature increased as the temperature fell. The curve given by the formula

$$10^6 C\, k_t = \frac{33700}{273 + t} = \frac{33700}{T}$$

where t is the temperature and T the absolute temperature, coincided accurately with the observations of the first series of experiments. The determinations of k in the second series were 1 per cent. to 2 per cent. too high between 200° C. and 350° C.

The law of the variation of k is, therefore, an extremely simple one; *between 20° C. and 450° C. the coefficient of specific magnetization of oxygen varies inversely as the absolute temperature.*

The author points out that this result is important to magnetic theory. Oxygen is of all magnetic bodies the most simple in molecular constitution. There is every ground for believing that the complete investigation of the properties of this body will give the clearest ideas as to the nature of magnetic phenomena.

The coefficient for air may be calculated by only taking the oxygen it contains into consideration. We have for the volume coefficient of air at one atmosphere pressure

$$10^6 \chi_t = \frac{2760}{T^2}$$

This formula may be used as a temperature correction in all magnetic determinations carried out in air, assuming that the composition of air does not vary with the temperature. This coefficient relating to a cubic centimeter of air rapidly decreases as the temperature rises. At 20° C. it makes a 4 per cent. correction necessary in the case of water; at 400° C. its value is five times less.

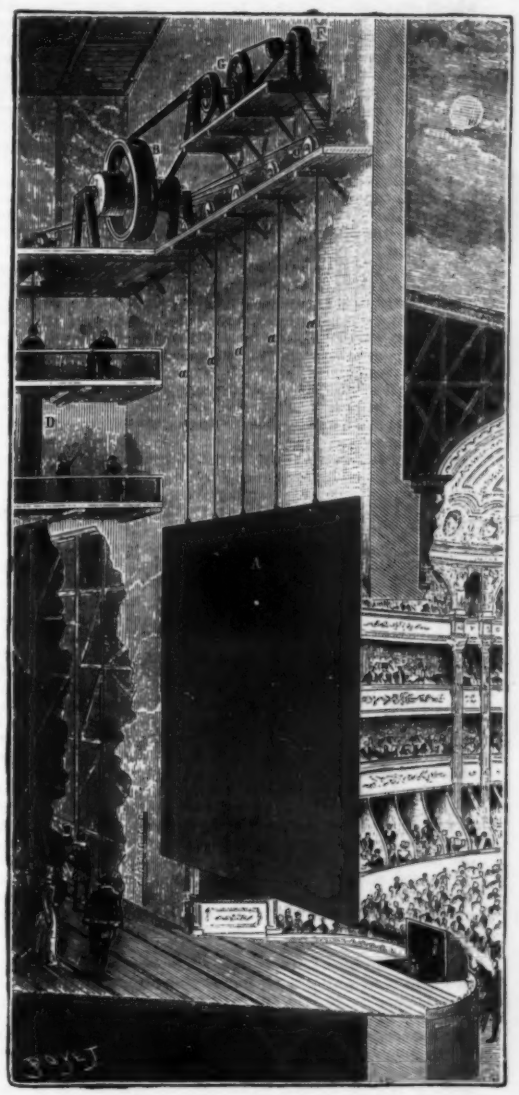
THE ELECTRIC CURTAIN OF THE COMEDIE FRANCAISE.

THE national theater of La Comedie Française has just inaugurated the electric maneuvering of the drop scene. This installation is, we believe, unique in Europe at this moment. Thanks to the obligingness of Mr. Claretie, director of the theater, and to information furnished by Mr. Besson, chief electrician of the Edison Central Station of the Palais-Royal, we have been permitted to study this application in all its details, and we shall give a description of it.

The mounting was done by the Edison Company with the aid of Mr. Anton, chief machinist of the theater. The curtain was operated electrically for the first time on the 23d of November, 1892, on the occasion of the first representation of "Jean Darlot."

The accompanying figure gives a general view of the arrangements adopted. The curtain, A, is held by five ropes, *a*, *a*, *a*, *a*, *a*, which pass over pulleys, O, at the upper part and wind around a wooden drum, B, to which motion may be given in one direction or the other in order to cause the curtain to rise or descend. Such motion is obtained through a transmission, G, by the aid of a belt established upon an electrical shunt motor, F. A counterpoise, D, held by a rope around a fly-wheel, B, assures an equilibrium at every instant. The conductors that lead the energy to the motor pass through the side scenes and end in the prompter's box at a maneuvering dial placed to the right. Through the position of a reversing lever, it is easy to change the direction of the motor's running, and consequently to effect a motion of the curtain.

The total weight of the curtain is about 880 pounds, which is entirely balanced by the counterpoise, D. The motor, therefore, has only to conquer the friction of the system at the rise and descent. The motor is of two horse power. The electric current is taken from the circuit board of light supplied by the Edison Central Station of the Palais-Royal. At the place of arrival is found the collector with a circuit breaker and an interrupter. A first derivation is established for supplying the inductors of the motor. The circuit afterward continues and the conducting wires end at two semicircular metallic parts placed upon an insulating support.



ELECTRIC DROP SCENE OF THE COMEDIE FRANCAISE.

This apparatus, as a whole, constitutes the rheostat dial, whose resistances are variable at will.

A lever movable around the axis is designed for closing the circuit in one direction or the other, according as it is raised or lowered. Through this maneuver the direction of the current is changed in the armature, and the curtain is consequently set in motion. The brushes of the motor are replaced by carbon rubbers, in order to prevent too strong sparks at the changes of direction of the running. These give entire satisfaction. The angular velocity is 1,800 revolutions per minute. The various keys of the resistances correspond to different degrees of velocity of the curtain.

Three different velocities in the descent and two in the ascent are admitted, according to the scenic effects to be obtained. The maximum velocity of descent is 5 feet per second; the medium is 3·6 and the minimum is 2·5. The velocities of ascent are respectively 2·5 and 3·6 feet per second. At the start the intensity is 60 amperes at the maximum velocity, 40 at the mean and 20 at the minimum. While moving, the intensity falls to 20, 15 and 10 amperes. The total travel of the curtain is 31·5 feet.

To the electric maneuvering is joined a system of signal bells. One of these, placed in the prompter's box, is controlled by two buttons arranged in the side scenes, to indicate to the prompter the precise moment

* From the *Comptes Rendus*, December 26, 1892, vol. cxv., No. 26. Abstract.

at which the curtain must be raised, everything being ready upon the stage. Moreover, the prompter, in maneuvering the rheostat, at the descent, causes the lever of the dial to pass over a contact which sets in action several bells placed in the machinist's post and in different other places to announce the end of the act.

As may be seen from these few data, there is a question here of a very curious application of electricity to the stage. Let us add that the spectators are both charmed by a grand play and interested by a new maneuver.—*La Nature.*

THE DUALITY OF THE MIND.

By Benjamin Ward Richardson, M.D., F.R.S.

If those who have never studied the subject of the duality of the mind are not astounded with its importance when they arrive at the close of this short essay, I shall feel sure that a fault of my own has been committed; that I have failed, in short, in making a momentous study clear in respect to its quality. The duality of the mind is a subject of commonest everyday conversion, and yet it eludes observation. It is an open question in a sealed book. The most frequent forms of speech reveal our general knowledge of the duality, and yet we treat mind as if it were always unity—unity in thought, in action, in expression.

In my present effort I shall be led to consider the qualities of the mind as dependent upon certain well defined anatomies of that system of the body we call the nervous system. In the lower forms of life we discover a cord or line of nervous beads or ganglia, from which emanate a series of nervous lines or nerves to all the moving structures. When these lines of nervous cord, with their expanses, exist alone, we have animals that live and move almost altogether automatically. They make progression after what may be called a stereotyped fashion; they exhibit what have been named as instincts, modes of movement, by which they seek for the food that sustains them; they have organs of sense by which they are rendered conscious of obstacles in their way, and from which they move; but all through the actions they perform are mechanical, and not under the direction or the influence of reason. In this system also the motions called the passions have their centers; for the passions also are automatic.

When we ascend into the higher scale of being, we find, in the highest type of being, man, a much more elaborate arrangement. We find two definite nervous systems—one ganglionic, in lines of nervous structure, with connecting ends, or nerves, supplying all the organic parts, and ministering to the involuntary or vegetative life; the other much more complicated, a system in itself for the purposes of volition, a system which is the seat of the mind, a system which, through the senses of taste, touch, smell, sight, hearing, receives the vibrations of the external universe, treasures up those vibrations in concrete form and order, and gives them out in action, inspired by what we call will or voluntary life.

It is with this last-named system we have now to deal. In it lies the duality; it is the center of the dual faculty or faculties. It is constituted for a dual action, its anatomy tells its duplicate function. In the ganglionic system all is unity; it is a mechanism automatic in its work, steadily charged up and steadily giving up its force as it is charged; a continuous energy in waking hours and sleeping hours alike. Certain acts must be done, whether we will or not, that life may be continuous. The heart must beat, the intestines must propel, the glands must secrete and excrete, the arteries must be controlled or regulated, and by and through the involuntary centers of life all this work is done. But what we will ourselves to do is done by its own system, called the cerebro-spinal. Is this system single or dual?

Hitherto the world has been led into what may be called the metaphysical method of reasoning on this singular inquiry, and in consequence of this mode, we have learned to look upon the mind as dependent on one single organ, the brain. Few persons are professed metaphysicians, and metaphysical, as special studies, are gradually breaking up in the presence of physical. It is impossible, however, to describe how intimately many old metaphysical lessons have been engrafted into our thoughts, and have become beliefs. This is one. The metaphysical idea of mind is of unity with variety of phenomena, acting, sometimes, as if it were a double mind. Consciousness and common sensibility may be considered as having one seat mentally, yet they may be separated; there may be consciousness with a loss of common sensation or sensibility. A man conscious of all around him, as it would seem to the looker on, may be unconscious of his own existence, and may be subjected to what would be torture, were he conscious, without being aware of any injury inflicted on him. The mind, again, may be considered as one, and yet it may be open to contention or difference, as if it were seated in an organ that had double attributes. We find in all kinds of philosophies, in all kinds of theosophies, this contentious spirit; and I could fill many pages with teachings, all leading to the same kind of belief.

ORIGIN OF THE DUAL THEORY.

It is not until we come to the first half of this century that we arrive on a solid basis of knowledge, founded on direct observation of the meaning of these phenomena. The late Sir Henry Holland, in a chapter on the brain as a double organ, in his *Medical Notes and Reflections*, was the first perhaps of all to touch the border of the truth. He, in this essay, threw a light into an obscurity which he did not fully illuminate. Fortunately he was quickly followed by another keener and bolder explorer, who in 1844 announced the theory of the "Duality of the Mind" on grounds so sound that he may be said to have made an actual and astounding discovery in natural science. This discoverer, of whom probably very few heard, was the late Dr. Arthur Ladbroke Wigan, a man whose whole professional life was devoted to the study of the mind in connection with the body. Wigan was a good physiologist, a good anatomist, and an able physician. He was a man well acquainted with the leaders of his time, and was well advanced in interpretation of character. He had known the great surgeon Cline remove a peculiar form of insanity by lifting from the brain of an insane person a portion of bone that pressed on one particular part of that organ; and he was most assiduous in comparing diseased conditions of brain found after death with the phenomena of mental activity or inertia that had been presented during life on those from whom the brain had been removed.

It seems to me, from a careful examination of Wigan's treatise, that he was not so learned as we are now on the unity of action of that ganglionic or involuntary system of nerves to which attention has been already drawn. Had he known all we now know, his theory would have been much more strongly supported than it was when he propounded it. Perchance, too, in his desire not to be forestalled in his discovery, he rather hurried the publication of his great work and great argument. Be that as it may, he laid a foundation which is not likely ever to be permanently destroyed.

We have to turn to the grand voluntary nervous system, the cerebro-spinal system, in order to get at his meaning in its simple interpretation. All the external nervous expanses, whether commencing on the surface of the skin or on the surface of internal membranes, or in organs of sense like the eye, the nose, the ear, the tongue, pass, in collected lines of nervous cords, to the common center, the brain. Some, like the nerves of the organs of special sense, pass direct to the brain, others pass through the spinal cord, and, by decussation, make their way to the opposite sides on the brain, those from the left half of the body passing to the right, those from the right to the left brain; but all meet in the brain center, the "metropolis of humidity," as Hippocrates called it. To this extent, to the extent of nerves from many parts converging to a common spot, there is unity in the cerebro-spinal system. The duality commences in the brain center. There are two double brains—the two cerebrums, the two cerebellums. The cerebellum, or smaller brain, is dual, like the cerebrum, or larger brain, but is a motor co-ordinating center, not a mental. The true organs of the mind, the centers, in which the faculty of thinking and of willing takes place, are the cerebrums.

THE CEREBRUM AS A DUAL ORGAN.

The cerebrum is dual; it is made up of two hemispheres; so the anatomists have taught up to the time of Wigan. Here he breaks in, and propounds the new theory. "The term 'two hemispheres' is," he says, "strictly a misnomer;" the two together form very little more than one-half of a sphere, and they are really and in fact two distinct and entire organs, each respectively as complete and as fully perfect in all its parts, for the purpose it is intended to perform, as are the two eyes. Each cerebrum is a distinct and perfect whole as an organ of thought. A separate and distinct process of thinking may be carried on in each cerebrum. Each cerebrum is capable of a distinct and separate violition, and of opposing volitions.

Such, in a few words, is the starting point of this bold and original theory as set forth by its author, and on this he expands into many remarkable propositions.

In healthy persons one cerebrum, or brain, is almost always superior in power to the other, and is capable of exercising control over the volitions of its fellow, and of preventing them from passing into acts that admit of being manifested to others. In persons in whom one cerebrum has become the seat of functional disorder or of positive change of function of such a kind as to vitiate the mind or induce insanity, the remaining healthy cerebrum can still, up to a certain point, control the morbid volitions of its fellow. In this manner he conceives some are enabled to "*self-govern*" insane tendencies; but when disease of one brain becomes sufficiently aggravated to defy the control of the other, there is then exhibited one of the most common forms of mental derangement; while a lesser degree of discrepancy between the functions of the two brains constitutes a state of doubtful insanity or conscious delirium. In conditions with one brain diseased and the other healthy there may be lucid intervals, but with both brains diseased permanently there is no lucid interval. Insanity is the permanent mental state.

I have condensed in the above the essence of the theory of the duality of the mind. It is so simple, that he who runs may read it. I may say at once that accepted, on sound inquiry, it does more to explain the mental organization and function than any other that has ever been placed before the world. The importance of the theory is, however, the best of all reasons why it should not be too easily accepted. It should be tested in the most rigorous possible manner. Let us put it fairly to the test.

It may be objected to the theory that the two brains, although they are distinct in form, are made one by the interlacement of one brain with the other through the connecting bands or commissures, and especially through the great commissure, the corpus callosum. Wigan himself meets this objection with entire correctness. The corpus callosum is not an interlacement of the mass of the hemispheres; the raphé defines the distinction. The corpus exists as a floor holding the hemispheres together without connecting them. The anterior, middle, and posterior commissures, if they be purely commissural, are so to minor parts alone; the greater anterior-posterior commissure acts for communication from one part to another of its own sphere. It is a longitudinal as distinct from a lateral form of communication. Anatomically, there is no direct introcerebral communication. If there were, why two brains? If it be argued there are two, that one may act for the other in case of disease or accident, then is it the more certain that the two are distinct organs, either of which can act independently—which is, in fact, the whole argument.

If the two brains were one, acting as one in the healthy man, there must be perfect unity of structure, unity of capacity, unity of detail in every part, in order to sustain unity of function. If the two brains vary in details of form, there must be dual action. The argument of Wigan is that the two brains do vary in details of form, and since his time many facts have been recognized which strengthen his thesis and bring it nearer to proof.

The evidence is positive that one cerebrum can act and maintain mental activity without the aid of the other. The results of disease, the results of experiment, afford this required proof. Cruveilihier has reported an example in which a man, forty-two years of age, who up to his death enjoyed the use of all his senses, possessed the ordinary degree of intelligence, and walked, by the help of a stick, died of heart disease two days after admission into hospital. His intellectual faculties appeared to be entire. In this man, nevertheless, it was found after death that the left brain was three parts destroyed and replaced by watery fluid. The mental acts had long been carried on by the right brain. This is one only of many other examples. I could supply another from my own experience. It is unnecessary; it is certain that one cerebrum is sufficient to maintain mental activity, and so much granted, is it probable that each cerebrum (itself an independent organ) is so uniform in construction with its fellow-brain that it acts with it always synchronously, obeying the same impulses and sending forth the same volitions?

It is not probable; it is not possible.

The two brains vary much in weight, in consistency, in form. They carry different volumes of blood; they are fed by different arterial streams: they must, therefore, have nutritions differing according to the circulation that plays through them. There is, it is true, a certain common circulation of the return or venous blood in the sinuses by which the whole volume of blood in the cranial cavity is generally equalized; and in the cerebro-spinal canal there is a common space for the cerebro-spinal fluid; but these are not sufficient to reduce the two grand organs to a common unity. They balance the circulations, but they do not bring all into one; they do not interfere with the independent action of each brain; each brain receives and returns its own blood; each brain works, and if I may express myself in words true though plain, each works, and excretes, or perspires, according to the amount of work it executes.

The left brain, or that which supplies and animates the right side of the body, is the most active brain, as a general rule. Dr. Wigan propounded this view, and he was right in doing so. But since his death we have discovered a striking piece of new evidence in favor of his general theory. We have localized the seat of language in the left brain. We now know that with diseased conditions of one portion of the left brain there is developed, not simply paralysis of the right side of the body, but loss of speech—aphasia. To a large extent this fact alone declares the individuality of one brain, the left, and crowns the demonstration. No experiment that any man could devise would add to the completeness of this experiment produced by nature in the course of disease.

Taking the evidence as a whole, it appears to me that every point of it directs us to accept the duality of the mind as based upon the anatomical fact that we have two brains, as in the examples of two eyes, two ears, two hands, and as in other examples where two organs are required. When one organ alone is requisite there is one and no more: one stomach, one heart, one liver; and one united nervous or ganglionic system or no more.

ILLUSTRATIONS OF THE DUAL THEORY.

Up to the present point I have kept to what may be considered the material study of the dual theory. It is time now to inquire how far the said theory chimes in with the details of the mental phenomena we see ever going on around us. We talk often of the universe that environs us. We hesitate as we think of the vastness of that universe. How can we, merest mites of mites, read that seen and unseen space in which we float? We could not think of it with one brain; with one brain we should resolve into the immensity. We must have a grip of mind on the earth as we roll in space. There must be in our microcosm two living worlds with their homes or centers. Wigan expresses this by saying that "every man is, in his own person, conscious of two volitions, and very often of conflicting volitions, quite distinct from the government of the passions by the intellect; a consciousness so universal that it enters into all figurative language on the moral feelings and sentiments, and has been enlisted in the service of every religion."

The statement is most true, and explains in rational exposition many seemingly contradictory problems relating to individual lives and events.

I had the opportunity once of meeting the late Mrs. Booth at the house of a mutual friend. We discussed, as a matter of course, the work and results of the work of the Salvation Army. The topic to me was new, and found in me little of quickening sympathy. But I was in the presence of an enthusiastic, earnest, and able woman, and some things she said struck me forcibly. We were speaking of what is called conversion. "It is a phenomenon," she observed to me, "that you, even as a physiologist, ought to study. There is a man, steeped in sin: he is brutal to wife, children, parents; all domestic ties are as nothing to him; he is submerged in iniquity; you, I make bold to say, could do nothing with that man; you might as well attempt to raise a huge sunken rock out of the sea as lift him out of his lost position. But we succeed in reaching that man; we preach to him, reason with him, pray with him, and practically he becomes a changed being; foulness of speech ceases to fall from his lips; the home cruelty is to him a horror; he is as a little child, and as if he were literally born again."

"And after a time he relapses," I suggested.

"Sometimes, not always, and, as a rule, the very worst cases relapse least frequently; some never relapse; and if but one of this kind on being converted does not relapse, but progresses in what we call a reclaimed life, that one case alone is, or ought to be, a study for you and all men of science. We will not argue on the question of cause now, but I want to impress on your mind the facts, because it is on such facts, often repeated, that we stand so securely."

I admitted the facts, but we had not the time, if we had the inclination, to discuss causes. Mrs. Booth, I doubt not, had her explanation at hand; I have mine, and mine is founded on the theory of the duality of the human mind. Her model submerged man appears before me as one governed for long years by an evil brain. So long as that evil brain retained its dominant strength it ruled the man. But there came a time when that excited brain wore out into feebleness, when impressions upon it derived from the second brain

began to act with superior force; when doubt and contrition thereupon agitated the man; when he felt that he had in him two volitions beyond his mere animal instincts and passions. At this crisis a strong and earnest external nature fell upon him, roused into action his own better nature, drove his lower nature into obedience of fear, and temporarily or permanently transformed him into that which he had never yet experienced—into a man in full exercise of a newly developed strength. That man, physically and literally, was born again. We need not criticise the means employed for that regeneration; we will not, at this moment, question whether the training that followed the new birth was the best and only best; but we must admit the phenomenon of the change. There was about it no mystery; it was in scientific definition, an organic mental transformation; the awakening into life and living action of an organ in a state of partial inertia; a physical conversion leading to new action, and, if we like to say so, making a new man. No wonder from this reading, that the worst specimens of vice should become, under the change, the most lasting specimens of virtue.

I have related here a sharp and striking example of change of power, or dominance, from one to another center of the mind. But there are endless other illustrations quite as convincing. A youth and young man struggles for many years of early life in adversity. He lives according to his environments, and with one brain attuned to these he acts from them. Suddenly a better and latent brain becomes roused into action, and steadily the man rises in fame, becomes, perchance, a marvel of his generation. The now dominant brain carries all before it, until at last, under the wearing excitement, it ceases to burn with its usual light. It pales, it wearies, it depends on its lower helpmate, and gradually the friends of the man observe how he has changed. He falls back on his old narrowness; he fears poverty while he is rich; is intent on making money; harasses himself about domestic troubles; loses his exalted powers of memory, imagination, analysis, construction; is restless as to place; is filled with internal contentions; thinks the world inappreciative of his genius if the world is not at his feet, and when it is there feels how much all is vanity and vexation of spirit. Then suddenly he goes out, from absolute failure of the once greater brain, and, like a star in the firmament, rapidly extinguished, is seen no more. His ashes remain to be worked up into new forms for human apprehension, while the vibrations he has sent forth during the progress of his mortal life remain in motion for evermore, for the delight or instruction of generations unborn; creations of his brain that may outlive for ages their projector.

Duality of the mind in its marked character is ever before us; there is not a single work of imagination portraying human character in which the duality is not exemplified. Fictionist and poet live upon it; and I notice recently that one of the most analytical and realistic writers of fiction in France, and one of the most popular, M. Guyot, recognizes not only the art but the science of the method. In describing one of his imaginary characters, or more probably a real character transformed from the ordinary daily life into his pages under a false name, he explains duality on the same principle that Wigan did long before him. He is dealing with a man who has two brains—brains which are not of the same mould, and therefore, not of the same action—and he writes his character from this standpoint with all the vigor of a master in literature and the precision of a man of science. Guyot is alone, as yet, among writers, in that he knows the physiological basis of his argument, and is one of a thousand who has used the argument with a knowledge of the foundation of it in material form. The writer of the wonderful Book of Wisdom knew the fact of duality perfectly. James the Apostle defined it: "A double-minded man is unstable in all his ways." Every poet, every playwright has known it; and our own national poet knew the duality so well, he never portrayed a character without it. Hamlet is confessedly to himself a dual nature, and the actors who have represented him most faithfully have been they who have most keenly dissected out the two parts. Macbeth has a dual mind always in action, and shows the fact from beginning to end; while his wife, with one brain dominant to the end, stands out as if of single mind, until the overwrought organ gives way altogether, and allows a worthless, timorous, foolish brain to come into play. But the perfection of knowledge of duality by Shakespeare is in the rendering of Richard the Third in the night scene on Bosworth field. At dead midnight the king, in his tent, arises from sleep; "Cold, fearful drops hang on his trembling flesh," as he questions himself in his dual nature. "What do I fear? myself! there's none else by: Richard loves Richard;" "that is I am I. Is there a murderer here? No—yes, I am: then fly—what? from myself? Great reason: why?—Lest I revenge. What, myself upon myself? I love myself. Wherefore? for any good that I myself have done unto myself? O no, alas! I rather hate myself for hateful deeds committed by myself. I am a villain; yet I lie, I am not. Fool, of thyself speak well: fool, do not flatter. My conscience hath a thousand several tongues, and every tongue brings in a several tale, and every tale condemns me for a villain." And so the colloquy progresses into despair. "I shall despair. There is no creature loves me; and if I die, no one will pity me: nay; wherefore should they? Since that I myself find in myself no pity for myself."

A late friend of mine, a fine dramatic critic of the old school, who knew Edmund Kean, and who retained the gift of a walking stick of that famous actor, told me that in this memorable scene Kean so impersonated two minds that he seemed to bring two men actually on the stage contending with each other, and yet filling always the same place. "The actor so changed expression that the character doubled before the eyes of the audience, leaving it spellbound, and as if every one had forgotten to breathe."

Wigan was of opinion that no single person has the two brains exactly balanced. He considered the most powerful mind was that in which the two brains, both being healthy, were nearest to each other in capacity; but he believed that that was also a good condition in which one brain took the leading part, and in which the other brain, in accord with the stronger, lent the stronger its assistance. A mind sustained in this manner was one strong for endurance, and one that was able to undertake, with certainty of successful work, the most difficult and hazardous labors. The minds of men like Cromwell, Washington, Wellington, Franklin, would be of this last-named cast, while the minds of the giants of intellect, of Napoleon, Newton, Columbus, would be constructed on two brains of equal power, both in unison in their capacity and will for action.

In common life the two brains act together with sufficient unity to maintain the mind in a fairly balanced state, but there are conditions in which the divergence is so considerable that balance is broken, and then there is what we call insanity. Wigan sums up the argument in a very clear manner. He says: "I think it may be assumed, without risk of contradiction, that the fact of each brain being perfect, and a complete instrument of thought, is abundantly proved. That each, while in health, corresponds in action with its fellow, is obvious from the fact that this unison and correspondence give only one result, as in the case of two eyes producing single vision. That when, from any cause, one brain is disordered, a discrepancy in the two processes of thinking takes place. That the healthy brain (aided by the action of such of the organs of its fellow as are not affected by the disorder which disturbs the others) can, in nearly nine hundred and ninety-nine cases in a thousand, according to the usual proportion in this country, control all manifestations of morbid emotion or judgment, but that the thousandth case is the madman."

The balance is sufficiently preserved on the grand scale to prevent the intrusion into the world of an excess of insanity. At the same time there is a wide range of diversion, short of obvious destruction of balance. Heredity here plays a leading part.

EFFECTS OF HEREDITY.

It must do so. In the course of heredity particular forms or moulds of bodily type are constructed in line. Features external in character typify the family stock; features internal in character typify the family stock. We see one set visibly in form; we see another set visibly in action. Why not? The two brains are cast on the hereditary plan and follow the laws of heredity. Give, therefore, a type of irregularly formed cerebra in a family, and almost of necessity there will be some continuation of family proclivity. Toward this four kinds of construction unite: that of the enveloping bone or skull; that of the arterial vessels with which the cerebral masses are supplied with blood; that of the material out of which the brain substance is formed as a solid organ; and lastly, that of the cellular development, which is, I believe, of all the most afflicted by heredity.

In the case of other double organs than the cerebra, one organ is capable, under emergency, of replacing the other; that is to say, of doing the work which the other cannot accomplish. This occurs in regard to the kidneys, the lungs, the eye, the ear; and when it happens that the officiating organs are free of compression, so that they can grow, to use an ordinary term, to larger size under increased supplementary work done under pressure, one may become, in time, equivalent, in respect to work it can do, to two. But when the organs are always working under fixed compression, as in the skull, compensation of the kind named is not in the same way possible. It is true that an animal can live with one brain alone in action, and it is equally true that an animal can live with the larger part of both brains destroyed; but it is not compensation that is presented under such circumstances. The life is maintained with the intelligence lessened to the extent of destruction. The brain organs, that is to say, are not constructed for one of them to act unceasingly for the other. When one brain alone is injured, the other does no more than continue its own work, and the mind retains its lucidity according to the natural working of the part that is uninjured. In plain terms, the independency of the two organs is an inevitable fact. If they work in unison from the circumstance that they are similar in build, all the better; but the independency of the working is absolute.

I accept on my part the duality of the mind, and the independency of two brain organs as a demonstration. Everything we can put into test regarding the theory comes out clearly; and I doubt if there be any theory in physiology that bears so close an inspection.

PRACTICAL RESULTS.

It may be asked what practical results are derivable from this theory? Is it a mere curiosity—is it a grand exposition? It comes before me as one of the grandest expositions ever revealed in the study of mental science; and I will, in conclusion, indicate a few, very few, natural secrets it seems to me to unfold.

In the first place the dual theory gives the best explanation of certain forms of insanity, and specially of those forms of insanity which are hereditary in their character. Some insanities spring from direct external influences, due to substances taken into or produced within the human organism. These are probably effective on both brains, and the effects may be considered as deliriums or intoxications, like those produced under first intoxications from alcohol, the sulphur compounds like mercaptan, or the vapors of chloroform, ether, or anylene. They are temporary casualties at first, and when the two brains are naturally balanced and healthy they do not fail to be removable under judicious treatment. But the true and most lasting forms of insanity are those where, from the parental stock or type, the two brains are out of tune by natural or unnatural construction. Under such conditions one brain suffering from exhaustion or excitement becomes out of accord with the other; two minds then exist in the same organism, and in the difficulty the want of balance is declared in the irregular and delusive thoughts, expressions, and deeds of those affected. Again, in some, in whom heredity of construction plays no important part, irregularity of development of brain or of work produces irregularity of structure for the accomplishment of mental labor. One brain becomes too excitable or too powerful for steady balance. Its possessor is charged with one series of ideas; and these, unchecked, run wildly into conflict with the commoner brain work, and, gaining supremacy, produce the imperfect equilibrium which indicates the mind diseased. The two brain centers unbalanced, mental aberration is an easy sequence; as is another condition leading to aberration through the passions. The passions which so influence mankind are centered in that involuntary nervous system which we call the ganglionic. They are spontaneous acts, and would be always in motion were they not governed by the reasoning centers, the two cerebra. When, then, there is discord in the reasoning centers, the passions from their seat have free play, and emotions of ungovernable kind lead to animal propensities and acts which of themselves are often raised into the worst so-called insanities. Or, when the two reasoning centers are both of low character, then again the passions prevail. Or, once more, when the governing centers of strong character become enfeebled from overstrain or prolonged labor, the same loosening of passions long held in abeyance takes place. In this way it sometimes happens that men who for many years have been the powers and lights and models of the circle in which they move, drop in their early senility into animal sensuality, and occasionally themselves defame a name they might have left in the brightness of fame. The effects of degenerations, from the opium habit, alcoholic inebriety, and other depressing influences in earlier life, lead also to reduction of controlling power of one or both of the cerebral or brain centers.

As we gain a physical insight into these modes of motion belonging to our common humanity, a world of light breaks upon our view, teaching wisdom as well as knowledge, and charity as the outcome of both. Our hard-and-fast and narrow dogmas pale in this light. We see before us the healthy, the diseased, the criminal minds at their work. We dissect out the principles leading to motives to detect that motives, good and bad, have their constructive causes, and that a person actuated by good or bad motives must be constituted, temporarily or permanently, for the one or for the other. Some day in the future our criminal codes will have to be reformed altogether, on a system evolutionized from a knowledge of this physical basis of good and evil.

The grand lessons, the immediate lessons, derivable from the study of the duality of the mind, and of the passions as automatic wills distinct from the mind, the grand lessons have reference to the education of communities, first, into structural form and strength; and, secondly, into cerebral activity with uniformity or equality of power. When we see the effects of debility and deformity of the framework of the body in modifying the equality and power of the central cerebral organs, we learn that with physical impoverishment there can be no intellectual advancement, no control over the animal emotions and passions, no great types of intellectual capacity, no true and sane balance of mental powers. In plain words, we see that to secure sane balance we must build up the mansions of the mind with artistic skill before we attempt to furnish them.

When we have built we must furnish with mental attributes of the best order, for the best purposes; never oppressing one brain at the expense of the other, or the two as one. Dr. Wigan knew the famous statesman William Pitt, whose reckless father, the Earl of Chatham, forced him to unnatural labor when as a lad he was overburdened with the variety of topics, by any saying, "Courage, my son: remember there is only — cyclopædia to learn." He saw the great statesman at Bellamy's, when, in a state of collapse, after the excitement of debate, with a countenance bearing the air of insanity, he would swallow a steak almost without mastication, drink a bottle of port wine almost at a draught, and then, barely wound up to the level of ordinary impulse, repeat the process twice or even three times in the course of the night; a frightful example of over-cultivation of brain before it had attained its full development, and so exhausted by premature and excessive moral stimuli that when its ambition was sated, it was incapable of even keeping itself in action without the physical stimulants spoken of. Men called the sad exhibition the triumph of mind over matter; Wigan called it the contest of brain and body with victory obtained at the sacrifice of life. To which he added that "it is not to compare little things with large to speak of similar examples in humble life, for the mind of the humblest mechanic is as important in the scale of creation as that of a king; and I have seen," he continues, "the same wretched results in the case of a little boy perched at a desk as the accountant in the shop of a draper, who had to attend, in rapid succession, to forty or fifty young men bringing their notes of sales to him to be verified and registered, to give correct change to every one while his attention was solicited by half a dozen at a time; and who, rendered responsible for the slightest error on pain of dismissal, went to bed in a state of exhaustion worse to endure than the most excessive bodily fatigue."

In such examples, training of the two mental centers into uniformity of action is simply impossible; and yet in this day, fifty years after the above was written, the same primary errors go on despite our enlightenment, and, as might be foreseen, with increasing insanity; broken balance of mind on every side, a second Babel the ultimate destiny.

I close here, leaving many other lessons that could easily be drawn, for inference rather than description. Suffice it to sum up with these facts: (1) That all mankind is dual in mind by natural construction, so that a congregation of human beings, large or small, a family circle, a private meeting, a parliament, a nation, must always be reckoned as twice its individual number before its mental constitution and strength can be properly appraised. (2) That the efforts of all should be directed to the proper construction of the casket of the mind and the physical powers working it. (3) That mental work should be for progress in ways of unity of purpose, toward greatness of life and character.—*The Asclepiad.*

MR. PASTEUR'S BIRTHDAY ANNIVERSARY.

THE section of medicine and surgery of the Academy of Sciences, at the instance of Dr. Bouchard, one of its members, desired to take up a subscription in order to offer a souvenir to Mr. Pasteur on the occasion of the seventieth anniversary of his birth (December 27, 1892). The Institute, the friends and admirers of the great chemist, and all those who have profited by his discoveries, desired to contribute to this homage. The work of executing a commemorative medal was confided to Mr. O. Roty, one of our most distinguished sculptors. No better selection could have been made than that of

the eminent artist who has produced so many fine works of this kind.

The medal, which was presented to Mr. Pasteur on the occasion of the memorable ceremony of December 27, is rectangular, and about seven centimeters in length. We reproduce herewith the obverse and reverse of it. On the obverse, Mr. Pasteur is represented in profile. The resemblance is perfect and the sculpture is vigorous and energetic. Surrounding the profile is the following inscription: *Louis Pasteur. Ne a Dole le 27 Decembre* 1822." Beneath are engraved the following words which sum up the magnificent career of the illustrious scientist: "*Pour la Science, la Patrie, l'Humanité.*" The reverse carries the following inscription: "*A Pasteur, le jour de ses* 70 *Ans. La Science et l'Humanité reconnaissantes. 27 Decembre* 1892."

GOLD MEDAL PRESENTED TO MR. PASTEUR ON THE OCCASION OF THE SEVENTIETH ANNIVERSARY OF HIS BIRTH.

This artistic souvenir was delivered to Mr. Pasteur by the president of the Academy of Sciences in a velvet case. The medal is shown in two parts in this case, which contains on the one hand the obverse, which is of gold, and the reverse, which is of silver. Under these two parts there is a silver plate which carries the engraved text of the letter addressed by the members of the section of medicine to the president of the Academy of Sciences. The case is closed by a cover upon which there is a plate of chased cast bronze. A laurel leaf is engraved upon it with the following words: "27 *Decembre* 1892, *a Pasteur.*" The presentation of the medal took place in the large amphitheater of the new Sorbonne in the presence of a crowd of persons. Mr. Carnot, President of the Republic, had intended to honor the ceremony with his presence.

After a series of speeches by Mr. C. Dupuy, Minister of Public Instruction, and Messrs. D'Abbadie, Bertrand and Daubrée, of the Academy of Sciences, the great English surgeon, Mr. Lister, presented the homage of gratitude of medicine and surgery to the creator of the Pasteur doctrine. Mr. Bergeron, perpetual secretary of the Academy of Medicine, Mr. Sauton, president of the municipal council of Paris, and Mr. Brouardel, dean of the Faculty of Sciences, spoke in succession. Then the delegates from foreign academies, universities and learned societies defiled in turn before Mr. Pasteur and presented to him addresses, registers of signatures and medals. Mr. Ruffier, mayor of Dole, where Mr. Pasteur was born, presented the illustrious scientist with an album inclosed in a case with the arms of the city and containing a facsimile of his register of birth, as well as a photograph of the house in which he was born.

Mr. Pasteur, whose tears betrayed his emotion, got his son to read his address, which was notable for simplicity and modesty and especially for the grandeur and elevation of its ideas. The following are the passages that were addressed successively to the foreign delegates, to the young men and to those who are looking forward to the future:

"You delegates of foreign nations who have come from so far to give a proof of sympathy to France, you bring me the profoundest joy that can be experienced by a man who believes invincibly that science and peace will triumph over ignorance and war, that people will come to an agreement not to destroy, but to build up, and that the future will belong to those who will have done the most for suffering humanity. I appeal to you, my dear Lister, and to all of you illustrious representatives of science, medicine and surgery.

"Young men, young men, have confidence in those sure and powerful methods of which we as yet know only the first secrets. And do not, any of you, whatever be your career, allow yourselves to be affected by disparaging and sterile criticism, do not allow yourselves to be discouraged by the sadness of certain hours that pass over a nation. Live in the serene peace of laboratories and libraries. Say to yourselves in the first place: What have I done for my instruction? Then, in measure as you advance: What have I done for my country? Up to the moment in which you will perhaps have the immense happiness of thinking that you have contributed somewhat to the progress and good of humanity. But whether or not the efforts be more or less favored by life, it is necessary, when one approaches the great goal, that he shall have the right to say: I have done all that I could.

"Gentlemen, I express to you my profound emotion and my deep gratitude. Just as, upon the reverse of this medal, Roty, the great artist, has hidden under roses the heavy date that weighs upon my life, so you have desired, my dear confreres, to give to my old age the spectacle that could rejoice it more, that of this living and loving youth."

The ceremony of the 27th of December was full of grandeur. These homages, rendered with so much enthusiasm to the man who personifies labor and scientific genius, and who lavishes the inappreciable benefits of his discoveries with a disinterestedness without limit and an absolute abnegation, was an inspiring spectacle.—*La Nature.*

MAMMALS COLLECTED BY MR. DYBOWSKI IN THE INTERIOR OF AFRICA.

The Minister of Public Instruction, the Minister of the Marine and the Administration of the Paris Museum of Natural History have responded to a general desire in organizing successively, at the Garden of Plants and the Palace of Industry, exhibitions at which the public has been able to examine the collections brought back by the missions sent to the Saint Paul and Amsterdam Islands, Campbell Island and Cape Horn, by the first expedition of Mr. De Brazza, by those of Mr. Bonvalot and Prince Henri of Orleans, and finally by the recent expedition of Mr. Jean Dybowski through Congo, the region of Oubangui and the country which extends to the south of Lake Tchad.

This latter exhibition opened its doors on the 16th of November, and since that date a stream of visitors has continued to pour into the museum to examine the admirable series of arms, instruments, costumes, natural history specimens and photographs that Mr. Dybowski got together during his long peregrinations through interior Africa.

The traveler has himself, in his public lecturcs, given a summary narrative of his expedition, and some of our learned colleagues will doubtless take it upon themselves to give the readers of the *Naturaliste* a general idea of the anthropologic and ethnographic objects, of the living or dried plants, and of the rocks and minerals

MR. JEAN DYBOWSKI.

brought back by Mr. Dybowski. We can therefore leave aside everything relating to the physical aspect, the geological structure, the flora and the ethnography, and occupy ourselves exclusively with the fauna.

Among the mammals whose skins Mr. Dybowski has brought home, there are no large anthropomorphous monkeys, no gorillas and no chimpanzees, but thumbless apes, guenons and a baboon. The apes (*Colobi*) do not belong, as might have been expected, to the species that has been described by Sclater under the name of *Colobus Angolensis*, and which is found at Angola and upon the shores of the Loanda, but are allied to the *Colobus guereza*, Rupp., a species discovered in Abyssinia. The guenons must be referred to several species, to wit: *Cercopithecus ascanias*, Audeb., already met with in French Congo by Messrs. Thollon and Brusseaux, and perhaps identical with *C. picturatus*, Matt., of Angola, as Mr. Barboza du Bocage seems disposed to believe; *C. Erxlebeni*, Puch. and Dahlb., likewise met with in Congo by Mr. Brusseaux, but probably not descending as far as to the Portuguese possessions; and *C. cephus*, L., and *C. nictitans*, L. As for the baboon, that is probably the *Cynocephalus anubis* (F. Cuv.), which is not found

Fig. 1.—FRUGIVOROUS BAT OF CONGO (EPOMOPHORUS MONSTRUOSUS).

in Angola, but has been already met with to the north of the equator.

The Lemuridæ are represented by but a single species of the genus *Galago*, probably new, at all events, very distinct from the *Galago Monteiri* and *Senegalensis*.

A certain number of bats figure in the collection. Some are insectivorous (*Microchiropteres*), while others —and these are the most remakable by their physiognomy and dimensions—are frugivorous (*Megachiropteres*), of the species called, on account of its hideous face, *Epomophorus*, or, better, *Hypsignathus monstruosus*. The epomophores, which in Africa represent the rossets (*Pteropus*) of the Mescareigne Islands of Asia and of Oceanica, are, in fact, divided into two groups, the first, true epomophores, having well developed scapular pouches in the males and lips simply folded, and the second (Hypsignathes) having no scapular pouches, but presenting wide cutaneous expansions upon the end of the snout. These are largely developed in the specimens brought home by Mr. Dybowski, and give these bats an aspect so much the more repulsive in that the labial folds are shrunken and covered with a sort of warts. The head, surmounted by pointed ears, and with two large eyes flush with the skin, resembles that of a horse, or, rather, that of a hippopotamus. It appears very voluminous as compared with the body, which is deprived of a tail, and which, in repose, may be completely enveloped by the wings, as if by a mantle. The wings, in fact, have a spread of thirty inches, that is to say, are three times the length of the body. They are attached to the second phalanx of the second anterior finger, which is provided at the extremity with a strong claw, as are the posterior fingers. The surface of the alar membranes is nearly smooth and of a blackish shade, while the body and a part of the head are covered with short fur of a dark brown, verging on russet on the lower parts. The snout is bare, and the lips, on separating, disclose strong canines, which give the animal the character of a carnivore. It appears, however, that, like the rossets, this species, despite its vampirish physiognomy, is exclusively frugivorous and lives principally upon mangoes. It is found from French Congo to Gambia.

Among the Insectivora, we may mention a form just as remarkable, and still rarer in collections. We refer to the *Potamogale velox*, discovered by Du Chaillon in Gaboon thirty years ago, and found again later on by Marche in the same country, and by the Portuguese lieutenant, Bayao, in the territory of Angola. This animal, which Du Chaillon took for a carnivore, and which, in fact, offers some resemblance to the weasels by its slim form, and to the otters by its glossy coat, belongs in reality to the same order as the desmans, and is still less adapted than the latter to an aquatic existence. It has a strongly depressed head, terminating in front by a sort of flattened snout, provided with long, stiff mustaches. Its ears are of medium size, its eyes are extremely small and scarcely visible, each of its jaws is armed with twenty teeth, its body is slender and supported by legs so short that the animal seems to crawl upon the earth, and its tail is elongated and tapering, and strongly compressed laterally for the greater portion of its length. This latter organ is evidently intended for acting upon the water after the manner of a scull. It is bare and scaly in its terminal portion, but provided with an abundance of fur at its basilar part. The separation between these two parts is abrupt and oblique. The paws, contrary to what might be supposed, present but feeble rudiments of membranes, and the toes, five in number, are almost entirely free and armed with small claws. The fur that covers the head and body is as soft and glossy as that of an otter, and is of a beautiful brown color, slightly speckled with white upon the upper parts, the lower parts, on the contrary, being of a pure white.

However, despite its qualities, this fur could hardly be utilized, as the animal is of small size, scarcely larger than a sewer rat. The species is represented up to the present in public collections only by a very small number of specimens, the Paris Museum doubtless being, thanks to Mr. Dybowski and Mr. Marche, the establishment best provided for in this respect.

The rodents appear to be extremely numerous in the regions explored by Mr. Dybowski. This traveler has, in fact, sent to the museum specimens of the *Anomalurus* of the species named *erythronotus* by Milne-Edwards, and remarkable by the maroon-red color of the median part of its coat, numerous squirrels (*Sciurus Stangeri*, Waterh., *S. rufohachiatus*, Waterh., *S. annulatus*, Desm., *S. erythrogenys*, var. *leucostigma*, Tem., *Xerus* spec., etc.), myoxides (*Graphiurus murinus*, Desm.), gerbilles, cricetomys (*Cricetomys gambianus*, Waterh.), rats of various species, aulacodes (*Aulacodus swinderianus*, Tem.), and a hare (*Lepus ochropus*, Wagn.?)

Among the carnivora there figure a cat (*Felis caffra*, Desm.), with which Mr. Barboza du Bocage seems disposed to assimilate the *F. chrysthrix* of Johnston, several genets (*Genetta rubiginosa*, Puch.), some paradoxures (*Nandinia binotata*, Gr.), some mangoustes (*Herpestes gracilis*, Rupp., var. *melanura*, Martin ? *H. albicaudus*, etc.), some species of a sort of suricates (*Crossarchus fasciatus*, Desm.), and some jackals (*Canis anthus*, F. Cuv. ?)

Finally, among the ruminants, in addition to two bovids, male and female, of which Mr. Dybowski brought home the skulls and skins, and which offer the characters of the *Bos brachyceros*, Gr., we may mention some antelopes, some of them of large size (*Adenota Leche*, Gr.), and others of small size (*Cephalophus melanorheus*, Gr.) These latter, specimens of

FIG. 3.—THE ANOMALURE (ANOMALURUS ERYTHRONOTUS).

which may be seen mounted in the galleries of the museum, are pretty little animals, much smaller than squirrels. Their head is armed with small, straight, sharp horns directed obliquely backward; their legs are very slender, their tail is short, and their coat is glossy and of a grayish brown, passing on to black upon the posterior region and to white upon the upper parts of the body.

These antelopes are not the only ones that Mr. Dybowski met with. He had even prepared the spoils of a tragelaph (*Tragelaphus scriptus*, Pell. ?), and of a kob (*Kobus sing-sing*, Waterh. or *vultuosus*, Laur. ?), but the skins of these large animals, not having been sufficiently dried, in a region where the air was impregnated with humidity, had much to suffer from the long voyage, and could not be utilized. To these two species must perhaps be added the *Strepsiceros kudu*, Gr., for Mr. Dybowski tells us that, while pursuing the assassins of Crampel, he found in the forest an antelope's skull with turbinate horns that he was unable to bring with him.

The rapid enumeration that we have just made is, however, incomplete, for a more attentive study will certainly bring to light, among the mangoustes and the squirrels, and especially among the rats, a number of species that we have not mentioned. Finally, it is well to add to the list of the mammals the elephant whose magnificent tusks were brought home by Mr. Dybowski, who obtained them from the natives.—*Le Naturaliste.*

FIG. 2.—THE POTAMOGALE (POTAMOGALE VELOX).

THE CHEMICAL TECHNOLOGY OF DRYING OILS, OIL BOILING, AND BLEACHING.*

By Professor W. N. HARTLEY, F.R.S., Royal College of Science, Dublin.

THE invention of painting with oil originated with John Van Eyck and his brother Hubert, an eminent artist, about the year 1410. John Van Eyck discovered that linseed oil and nut oil became capable of drying, or of hardening, when they had been boiled, and that this property was increased by the addition of certain essential oils to prepare the medium for painting.†

In the year 1832 Saussure communicated to the Annales de Chimie et de Physique a paper on the action of oils on oxygen, at the temperature of the atmosphere (vol. 49, p. 235). After prolonged contact with oxygen, he found that the oils absorbed the gas, and produced carbonic acid and hydrogen, but in the case of drying oils the quantity of carbonic acid relative to the oxygen absorbed was much less than with non-drying oils. He mentions a statement contained in the "Traité de Chimie" of Berzelius, vol. v., that linseed oil which has been left in a bottle exposed to air becomes thick, and yields, when mixed with alcohol, a solution which is advantageously employed in the preparation of fatty varnishes, because it toughens the resinous body of the varnish.

In 1850, Chevreul read before the Academie des Sciences his great memoir, entitled "Recherches Experimentales sur la Peinture de l'Huile." This classical investigation of a purely technical subject was preliminary to a report on painting with zinc white, and many of the facts which he established it will be necessary for me to recapitulate.

Paint, such as is used for ordinary purposes, is composed, essentially, of three materials, without taking into account the colored pigments:

1. White lead, or sublimed zinc white.
2. An oil, generally linseed or poppy oil, which is ground up with the white lead or zinc white until it becomes a soft paste. This is mixed with variable preparations of linseed oil and spirit of turpentine.
3. A substance called driers, or siccative material, it may be linseed oil in which litharge is dissolved, or it may be linseed oil containing a compound of manganese.

Paint owes to the driers its property of drying more rapidly than it would do without it; and it is considered indispensable in buildings in all cases where paint, applied to wood, stone, or metal, would not be quite dry in 48 hours, or at most in 72 hours, after the first application.

The first question which requires an answer is, What chemical process takes place when a paint dries?

It was shown by Saussure that linseed oil absorbs oxygen; the same fact was proved by Liebig (*Annalen der Chemie*, vol. 33, pp. 110-115, 1840); but it was further proved by Chevreul that, when the oil contained manganese, it absorbed oxygen much more greedily; and when a manganese oil—that is to say, a boiled oil containing manganese—was mixed with linseed oil, the substance absorbed oxygen, from a limited supply of air contained in a closed space, until no trace of any other gas but nitrogen remained. The power of absorbing oxygen possessed by 100 volumes of linseed oil, mixed with that of 100 volumes of a mixture of [illegible] was as 4 to 100. This may be termed the measure of its drying power. A mixture of linseed oil with a little more than one-quarter of its volume of manganese oil had a power of absorbing oxygen four and a half times greater than either of the components of the mixture taken separately. In this case, he argues that linseed oil may be considered as a "drier" to manganese oil.

CHEVREUL'S RESEARCHES ON THE INFLUENCE OF LITHARGE, PEROXIDE OF MANGANESE, AND OF HEAT ON THE DRYING POWER OF LINSEED OIL.

Oil, boiled with litharge, was prepared, by heating the linseed oil in a cast iron vessel until it frothed, and after a period—which varied from three to six hours—about 10 per cent. of its weight of litharge was added, heating being continued for six hours longer. After this, the oil was left to settle, and drawn off from all deposit.

Leclaire boiled oil by heating linseed oil alone to a high temperature for five hours, and heating it for at least eight hours longer with manganese dioxide.

It was proved that linseed oil, without any addition whatever, if boiled for three hours, became a better drying oil than it was previous to the action of heat.

Oil boiled with 10 per cent. of litharge for three hours is a much better drier than when heated without this oxide.

Oil boiled alone for five hours is an inferior drying oil to one heated for only three hours.

Oil previously boiled alone for five hours, and boiled alone again for three hours, is scarcely altered in drying power, but it becomes a better drying oil if it is boiled the second time with litharge. It is inferior to a drying oil which has been boiled only three hours with litharge, without being submitted to a previous boiling.

Oil boiled alone for five hours, boiled for a further period of three hours with manganese dioxide, which has already been used for one operation, is very nearly as strong a drier as that which has been boiled with litharge under the same conditions; but it is superior to an oil which has been boiled with manganese dioxide for eight hours. This no doubt arises from the longer boiling with manganese having caused a larger quantity of manganese to dissolve, and that the quantity dissolved is in excess of that which yields the best result.

Finally, oil boiled for five hours, and then boiled alone once more for eight hours, becomes viscous, and the first coat requires a considerable time to dry. We thus see that the oxide of lead and of manganese in certain proportions concur with heat in increasing the drying power of linseed oil. Barruel and Jean very carefully investigated the action of light upon drying oils mixed with certain metallic salts, and established in a certain degree the fact that the drying of oils is a process of slow oxidation. (*Comptes Rendus*, vol. 26, pp. 577 to 580, 1853.)

* Lecture before the Society of Arts, London, February, 1893.—From the *Journal*.

† Guignet's article, "Fabrication des Couleurs," in Fremy's "Encyclopedie Chimique."

The following points in Chevreul's paper appeared to be difficult of satisfactory explanation, and suggested to my mind an examination *de novo* of the facts, as well as an investigation of the chemistry of the subject generally:

1. Linseed oil not boiled acted as a drier to the same oil boiled with manganese dioxide.
2. Linseed oil, boiled with either litharge or manganese, dried more rapidly when mixed with turpentine.
3. Oil mixed with white lead, zinc white, antimony white, and arseniate of tin acts differently, thus: The white lead dries most rapidly, the zinc white next, but antimony white and arseniate of tin are incapable of acting as driers; in fact, they retard the drying process.
4. Oil boiled alone for five hours, and boiled for a further period of three hours with manganese dioxide, became a superior drying oil to one which had been boiled with manganese dioxide for eight hours.

In 1889 I commenced a series of experiments which were continued for two years, on twenty-five weighed quantities of raw linseed oil, to which given weights of manganese compounds, dissolved in oil, were added. Each quantity was treated in a different manner: the temperature to which it was heated, and the time that it was submitted to the action of heat, were carefully recorded. The same quantity of each oil was spread over a given surface of glass, and the time which it required to set and to dry was recorded, and the color, transparency, and general appearance of the films were noted. The oils were then kept for six days, and again submitted to a similar trial. A second series of observations was then made, in order to verify the first, and a standard measure of tackiness was applied to each sample as it set and gradually dried. A portion of each sample was then mixed with white lead and with zinc white, the same weight of each pigment being added to a given weight oil. The paints were used to cover a surface of glass and of deal, the same superficial area being covered as far as possible by each sample. Samples of the best of these specimens were mixed with a given proportion of turpentine, and the drying power of the mixtures, both with and without admixture of zinc white and white lead, were painted on glass, and the result in each case noted. In all there were about 250 experiments, the voluminous detailed account of which I propose to omit, and merely state some of the conclusions arrived at:

1. The chemical action of a manganese compound when dissolved in linseed oil is that of a carrier of oxygen from the atmosphere to the oil. Manganese oxide takes up oxygen from the air, and transfers it to the oil, and in so doing it suffers alternately the opposite processes of oxidation and reduction.
2. To obtain the best result, the amount of manganese present must not exceed a certain small proportion of the oil.
3. Oil to which turpentine has been added dries more rapidly than oil without such addition, because the oil, being diluted and rendered thinner, spreads over a larger surface, and is in contact, therefore, with a much larger quantity of oxygen.
4. Turpentine does not act as a drier, that is, as a carrier of oxygen to linseed oil.
5. Different white pigments behave differently when employed in drying, because the more powerfully basic the properties of each pigment, the more powerful is its action as a drier. Lead oxide and white lead (basic lead carbonate) combine more easily with the acids of linseed oil than zinc oxide does. But zinc oxide dries better than antimony oxide, because it is a stronger base, while arseniate of tin has no basic properties, therefore does not act as a drier.

Different substances, that is to say, those without chemical action on oil, such as lampblack, sulphate of baryta, and sulphate of lead, cannot act as "driers."

THE COMPOSITION AND CONSTITUTION OF LINSEED OIL.

Linseed oil has been shown by Mulder to be a glyceride of a peculiar acid, called linoleic acid. According to the recent analysis of K. Peters, linoleic acid has the composition $C_{18}H_{31}O,OH$; so that the composition of the glyceride would be represented by the formula—

$$(C_{18}H_{31}O)3\}C_3H_5\}O_3$$

By saponification it yields glycerine .... $F_3\}C_3H_5\}O_3$
and a salt of linoleic acid..... $C_3H_5\}O_3$

Linoleic acid is a thin fluid oily liquid, of a slightly yellow color, with a high refractive power and feebly acid properties. It is insoluble in water, but dissolves in alcohol and ether easily. Its specific gravity at 60° F. is 0·9206. It does not solidify at 0° F.

It absorbs oxygen from the air very freely, to the extent of about 3 per cent. of its weight, and becomes tacky and viscid; finally it changes to a sort of varnish which, in thin layers on wood, dries, but on glass it only sets and remains tacky.

It readily forms salts which are difficult to obtain in a state of purity, since they decompose with the formation of acid salts. Peters has shown that linoleic acid is related to stearic acid $C_{18}H_{35}O\cdot OH$, into which it may be converted by hydrogenizing substances, such as, for instance, by the action of phosphorus and hydriodic acid. (*Journal Chemical Society*, abstracts, vol. 52, p. 126.)

Whatever the exact constitution of linoleic acid may be, it is certain that linseed oil for the most part is composed of trilinolein, though Mulder states that in addition it contains triolein, trimyristin, and tripalmitin.

Raw linseed oil contains the following constituents:

1. Glyceride of linoleic acid.... $C_{18}H_{31}O\}C_3H_5\}O_3$ or trilinolein
2. Water.
3. Mucilage, with the composition $n(C_6H_{10}O_5)$. On boiling with dilute acids this yields a gum and a sugar.
4. An essential oil. It is present in minute proportions, and its composition is not known.
5. A mixture of coloring matters of intense tinctorial power, viz., blue and yellow chlorophylls and erythrophyll.

The only useful and desirable substance is the trilinolein.

The relationship of linoleic to linolic and linolenic acids, and to stearic acid, will be made evident by the following formulæ:

Linoleic Acid.
$C_{18}H_{31}O\cdot OH.$

Stearic Acid.
$C_{18}H_{35}O\cdot OH.$

Linoleic Acid (a mixture). $C_{18}H_{31}O\cdot OH$ } consists of { $C_{18}H_{33}O\cdot OH$ Linolic. and $C_{18}H_{29}O\cdot OH$ Linolenic.

THE EFFECT OF OXIDATION ON LINSEED OIL.

It has been shown by Cloez (*Comptes Rendus*, vol. 61, pp. 336–339, 321–325, and 981–984; *Chemical News*, vol. 11, p. 136) that the effect of oxidation upon linseed oil is to destroy all the glycerine, and to produce therefrom carbonic, formic, and acetic acids, together with some acrolein. When boiled at a high temperature without the addition of any metallic oxide, the glyceride is decomposed, acrolein is formed and linoleic acid set free. In fact, whether oil is oxidized by air, by metallic oxides, or whether it be simply heated, the action in each case first leads to the destruction of the glycerine and the liberation of linoleic acid. But linoleic acid very readily absorbs oxygen, and the oxidized substance becomes a tough elastic solid, which is essentially a varnish.

In fact, the process which an oil undergoes in drying is not desiccation, or depriving it of moisture or of glycerine, but solidification, and the technical term "drying" is a misnomer. That, however, is of little consequence, if we really know what is the chemical action of the "drying" process. According to Mulder, the effect of a high temperature on linoleic acid is to convert it into an anhydride, which he called linoxyn. Later researches lead to the conclusion that the fatty acid is polymerized. But here it may be stated that when oxidized, even at a low temperature, it is certain that the glycerine is destroyed, and that oxidized products form a tough varnish, but it is by no means evident that they consist of linoxyn, and in this connection there is scope for some original investigation.

There are various methods of converting linseed oil into a drying oil or varnish.

1. Heating it to a high temperature with litharge.
2. Heating with red oxide of lead.
3. Heating with metallic lead.
4. Heating to a high temperature with manganic oxide.
5. Heating with manganese borate.
6. Heating with manganese oxalate.
7. By the joint action of air and heat upon the oil and manganous oxide, or a solution of manganese dioxide or manganous oxide in the oil.

In the processes 1, 2, 3, there can be no doubt that a lead of linoleic acid is produced, and that this facilitates further oxidation in air, by forming salts with some of the acid products of such oxidation, while the oxidation of the linoleic acid continues. Meeting with red lead favors oxidation by the compound itself conveying oxygen to the oil. In the case of metallic lead, it must be noted that the metal is dissolved. Chevreul has shown that, under certain circumstances, metals become driers to oils; thus he proved that sheets of metallic lead are capable of acting as driers to linseed oil. Livache has carefully investigated the chemical action of oils on lead, copper and tin, when in a state of very fine division (*Comptes Rendus*, vol. 96, pp. 260–263; and vol. 102, p. 1167). The lead was precipitated either as very small crystals or powder, from a solution of a lead salt in water by metallic zinc; it was moistened with oil, and exposed to air. An increase in weight was rapidly caused, the increase was more rapid the more the nature of the oil was that of a drying oil, and it was approximately proportional to the increase in weight of the respective fatty acids contained in the oils when they were exposed to the air for a long time. The tabulated statement below explains itself.

EXPERIMENTS ON THE OXIDATION OF OILS.
(LIVACHE.)

Oils in Contact with Lead.	Increase in Weight.		Increase in Weight in Corresponding Fatty Acids, exposed to Air for 8 months.
	After Two Days.	After Seven Days.	
	Per Cent.	Per Cent.	Per Cent.
Linseed	14·3	—	11·0
Walnut	7·9	—	6·0
Poppy	6·8	—	3·7
Cottonseed	5·9	—	0·8
Beech nut	4·3	—	2·6
Colza	—	2·9	2·6
Sesame	—	2·4	2·0
Earth nut	—	1·8	1·3
Rape	—	2·9	0·9
Olive	—	1·7	0·7

It will be seen that linseed oil is pre-eminent in its capacity for absorbing oxygen. This action of metallic lead as a drier is due to the metal becoming oxidized at the expense of the glycerine of the oil, and so passes into solution by combining with the linoleic acid, or with acetic or formic acid, caused by the oxidation of the glycerine. It is the destruction of the glycerine with concurrent oxidation of the fatty acid which causes the drying or hardening of the oil.

Livache has further investigated the acceleration of the oxidation of drying oils, and has shown that when a drying oil which has been treated with metallic lead, or with litharge, is shaken up with a solution of zinc sulphate, all the lead is precipitated from the oil, and zinc passes into solution therein. By manganese sulphate or copper sulphate the lead is removed by manganese or copper. Oil charged with lead dries in 24 hours, when spread out in a thin layer on glass; it will dry completely in 5 or 6 hours, if charged with manganese; in 30 or 36 hours, with copper, zinc or cobalt; and it requires more than 48 hours with nickel, iron, chromium, etc.

Although solidification of a drying oil charged with manganese takes place in from 5 to 6 hours, when spread in thin films, the solidification of thicker films requires a longer time. A temperature of 122° to 140° F. accelerates the oxidation of the drying oils, partly because the oil becomes more fluid, and partly because the oxygen is more active at a higher temperature. Hence oil which has been mixed with an equal volume of turpentine, or a light hydrocarbon, such as benzine, dries, as I have already explained, more rapidly than oil without such admixture.

When a boiled oil, prepared with manganese, is dissolved in an equal volume of benzine, and shaken up with air in a bottle, rapid absorption of oxygen occurs, especially about 120° F. If fresh air is repeatedly provided, the oxidation is sufficient to cause the liquid to become thick, and, on distilling off the sapient, a perfectly dry and elastic solid remains.

It is evident that an oil containing manganese is a very superior drying oil to one which has been prepared with lead.

This fact, however, is to be noted, that though a large proportion of manganese in an oil may hasten its drying, yet it is disadvantageous, because it does not form so tough a film. This arises from the film becoming hard upon the surface, and so protecting the oil underneath from absorbing oxygen from the air. The same conclusion has been arrived at by G. A. Buchheister, and is stated in the *Oil, Paint and Drug Reporter*, in an article on "Driers," translated from the *Drug Zeitung*, April, 1889.

Livache also noticed that, though the oils containing large quantities of driers dried, they afterward lost weight, and became viscous under the same conditions.

Buchheister has shown that pure linoleates of lead and of zinc are not driers; but if heated until it has turned brown, or begun to blacken, a lead drier becomes effective, although it contains less of the lead compound.

In this case, some compound of lead is formed by absorption of oxygen which either itself actually oxidizes or causes the oxidation of ordinary linseed oil.

Having treated of the materials used for producing boiled oil, and of their action upon the oil, let us now consider how the operation is brought about.

Process 1.—Oil is boiled at a high temperature, that is to say, it is heated until frothing and bubbles of gas escape, when litharge or a manganese compound is added.

Process 2.—Oil is boiled at a steam heat, with litharge or a manganese compound, in conjunction with a blast of air.

Process 1.—The chemical action in the first process is doubtless one which takes place in three stages. It commences by depriving the oil of water; in the second stage, it destroys the mucilage, by charring it; in the third, it destroys, in part, the glycerine, and sets free the fatty acids. After the litharge or manganese compound is added, there is formed in the oil a solution of lead salts of the fatty acids, or a manganese salt of the fatty acids.

The oil then, at the high temperature, loses glycerine by oxidation caused by the air, such oxidation being greatly facilitated by the presence of manganese compounds, which are repeatedly oxidized by the air and reduced by the oil, that is to say, they absorb oxygen and pass it over to the oil with great facility.

It matters little, so long as the ultimate action is oxidation, what salt of manganese or what oxide is used, if it be capable of undergoing processes of an alternate character called oxidations and reductions.

It is, however, certain that some manganese compounds are more suitable than others, owing to their more or less complete solubility in the oil, and their more readily undergoing the two different processes of oxidation and reduction in presence of air and of oil.

Process 2.—The credit of being the first to boil oil without resorting to the dangerous expedient of using an open fire, and a high temperature in the manufacture, is due to Mr. Charles Vincent. He used manganese compounds, or both manganese salts and litharge. An excellent description of the method of boiling oil for the manufacture of printing inks is given in the last edition of Muspratt's "Dictionary of Chemistry." With some modifications in technical details this process is carried out on a large scale at the present time in the preparation of ordinary boiled oil. The essential parts of the plant were a steam jacketed close boiler, with agitating gear, and a pipe for conducting a current of air into the oil by means of a blowing engine. From the head of the boiler there passed a funnel under the back of the furnace fire, by which the disagreeable products of the chemical action were conducted to a place where they were destroyed. These products, as already mentioned, are volatile fatty acids and acrolein.

Oil boiling as ordinarily carried out is conducted by means of litharge with compounds of manganese; in some processes these are mixed with salts of alumina and zinc. The oil so produced is brown and not clear, but it is clarified by keeping. Many samples of such boiled oil deposit insoluble matter when stored for some time, even though they may have become clear previously. This is not a desirable property. Sometimes resin is added to hasten its drying.

DEFECTIVE PROPERTIES IN BOILED OIL.

The defects to be noticed, even in the best samples of boiled oil, are the following:

1. The oil causes a brownish or yellow color to be communicated to white lead or zinc white.
2. The oil darkens pigments containing brilliantly colored metallic sulphides, such as vermilion, cadmium yellow and ultramarine blue.
3. Delicate colors are darkened by the oil when exposed to ordinary town air, that is to say, air which is not quite pure. This is the case even when the oils themselves may not injure the paints.

The causes of such alterations is, in nine cases out of ten, the use of lead driers. This has been pointed out in the *Oil and Colorman's Journal*, No. 1, 1889, p. 1071.

1. In the first place, boiled oil which contains litharge or other lead compounds takes a permanent brown color, which affects the purity of white lead, zinc white, and delicate pale tints.
2. Lead forms, with extreme ease, lead sulphide, which, in very minute proportions, is yellow or brown;

in larger quantity its color is black. The lead sulphide is readily formed by contact with other sulphides, as, for instance, vermilion, cadmium yellow and ultramarine.

3. Boiled oil, containing lead, is colored brown by exposure to air, owing to the presence of minute quantities of sulphureted hydrogen, which causes the formation of lead sulphide.

The remedy is obvious: no oil should be used which has been boiled with driers containing lead. In other words, oil should be boiled with pure manganese compounds only.

(To be continued.)

IMPROVEMENTS IN THE MANUFACTURE OF NITRIC ACID.

By OSCAR GUTTMANN, Assoc. M. Inst. C.E.

As is known, this system consisted of cooling the nitric gases in long earthenware pipes which are alternately connected on the top by bends and at the bottom by trapped bends, all discharging into a main drain pipe, so that the gases are as little as possible in contact with the condensed acid.

The improvements lately effected relate to the abolition of the trapped bends and to the purification of the acid. Fig. 2 gives a general idea of the improved condensing battery. B B are the pipes for the condensation, C are "chamber pipes," consisting of long earthenware pipes divided into compartments or chambers by partitions between each pair of sockets. These chambers are connected to each other by the small bends, B^1 B^1, so that while the gases pass through the upper bends from one chamber into the other, the condensed acid runs without interruption into the collector, F, without filling the chamber pipes, or bringing the acid too much in contact with the gases. A tee-piece, I, with taps, X X, allows the inlet to the collector to be temporarily closed, and samples drawn. A show glass is provided for controlling the process by the color of the gases passing. A pipe line, F^1, connects the collector with the tower. Those gases which escape condensation in the battery go to the Lunge-Rohrmann tower, H, and the last traces are carried through the receiver, J, into the chimney flue, K.

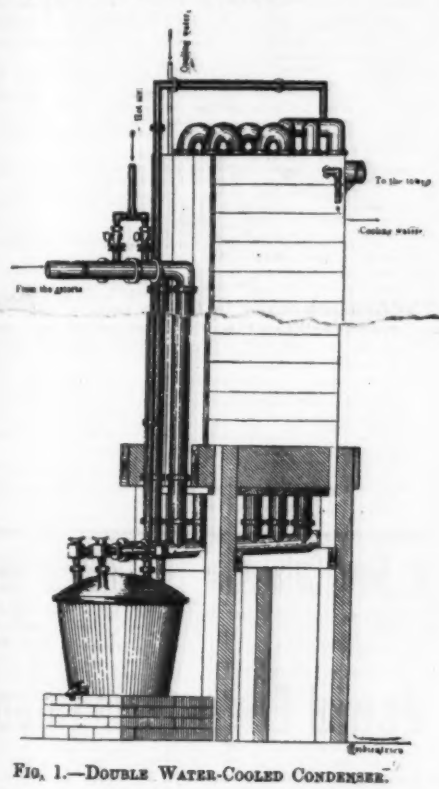


FIG. 1.—DOUBLE WATER-COOLED CONDENSER.

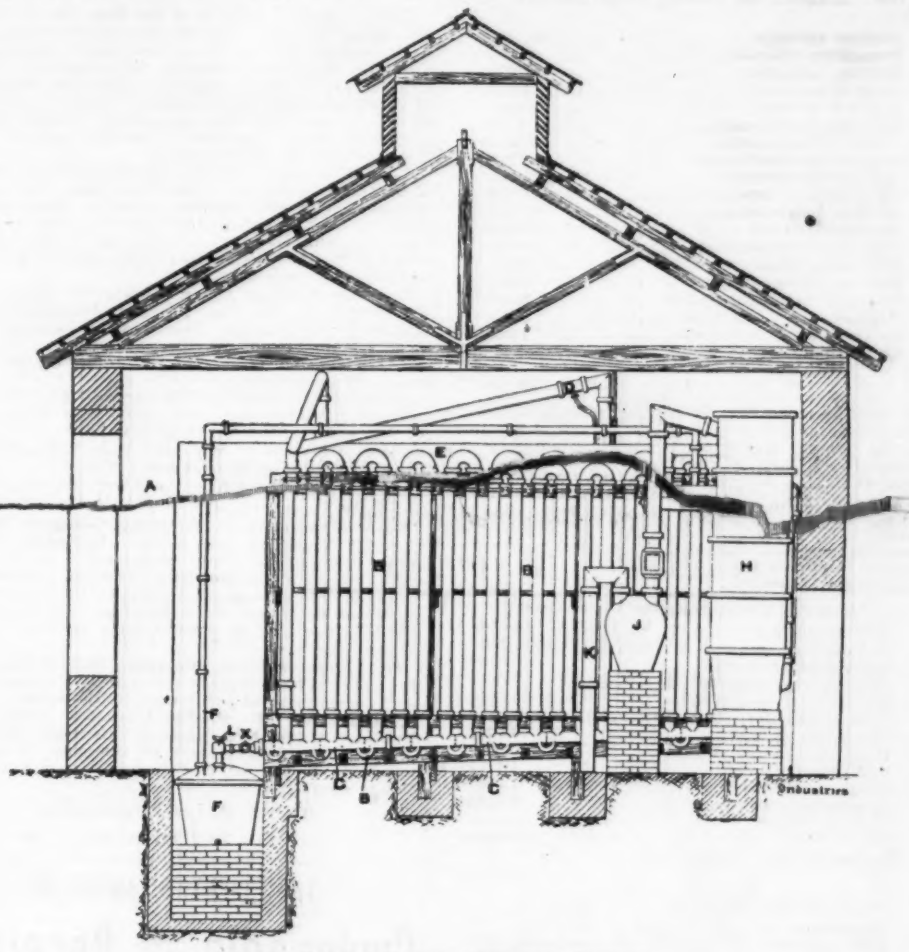


FIG. 2.—GENERAL VIEW OF CONDENSING BATTERY.

IMPROVEMENTS IN THE MANUFACTURE OF NITRIC ACID.

The injector, D, plays an important part in the process. It is well known that in distilling nitric acid the formation of nitrous acid cannot be avoided, and there will be more of it, the stronger the nitric acid is intended to be. In order to eliminate this nitrous acid the lengthy and costly process of bleaching the nitric acid has in other processes to be resorted to, the acid being heated in a water bath, and the nitrous acid driven off by blowing in air. In this way the strength of the acid decreases and there is a small loss. But it is known that nitrous acid can be converted into nitric acid by means of air and steam, and on this principle is based the new process of purification.

A small heating worm, made of wrought-iron gas pipe, is set in the flue of the retort, and compressed air blown through it. The worm is so dimensioned that the air comes out at a temperature of between 70° C. to 80° C. (158° Fah. to 176° Fah.) The hot air goes into the injector, D, which is placed as near as possible to the retort, in order that the air should come into contact with the gases before part of them had time to condense. Of course the retort gases are—with the manufacture of highly concentrated acid—a mixture of about 90 per cent. nitric acid, 2 to 3 per cent. nitrous acid, and 7 to 8 per cent. of water, all in the form of vapor, and thereby the best state is given for the reaction of the hot air. The transformation of the nitric acid takes place at the expense of a part of the steam, while most of the rest goes to the tower, as explained on previous occasions.

This process has several advantages. The injector produces increased draught on the retort, so that distillation takes place at a lower temperature. In this way less water is evaporated, and as the transformation of the nitrous acid also takes water away, the result is that all the acid finally obtained has a strength over 96 per cent. monohydrate. At the same time, even with hard firing, the nitrous acid will not be more than 1 per cent., and as a rule only 0·75 per cent. The consumption of coal is also diminished. In consequence of the high concentration of the acid about 5 per cent. of the theoretical yield is carried into the Lunge-Rohrmann tower, the excellent action of which allows, with proper regulation, nitric acid of 70° Tw. to be recovered from it. Although this form of condensing battery works so well, and is practically indispensable for the denitration of waste acids for the manufacture of arsenic acid and similar processes, where it is essential that the gases should remain in contact with the air as long as possible, it is undoubtedly true that for the ordinary nitric acid factory, especially where weaker acid is chiefly made, its rather large first cost is not always compensated for by the higher concentration and greater purity of the acid produced.

The unique qualities of the earthenware apparatus made by Mr. Rohrmann, such as its power to stand large variations of temperature and its exceptional toughness, have allowed the remodeling of the battery, the chief alteration being the use of a water-jacket to cool the pipes.

Fig. 1 shows a double water-cooled condenser. It is sufficiently large for two retorts of 12 cwt. of nitrate each, and has been working with excellent results in this country for the last three months. It will be seen that the number of pipes is reduced from twenty to five. They are connected at the bottom by one chamber pipe, and at the top by bends. The arrangement of injectors, draw-off and testing taps, the collector, and the pipe lines to the Lunge-Rohrmann tower remain the same as with the other battery. But the pipes are surrounded by a water-tight wooden box, into which cold water enters at the bottom and leaves it near the top. The frame of the box is independent of the pipes, so that they are only subjected to the pressure of the water. The chamber pipe is relieved by the sockets of the vertical pipes resting on a board with corresponding holes, which is fixed at the top of the box. The illustration does not show the way in which the pipes are isolated from the box. Half-inch India rubber rings are slipped over the pipes and pressed down by iron flanges, so that they form a waterproof joint both against the box and the pipes. In fact, even if the pipe should have become slightly oval from shrinkage in burning, the cavity is perfectly filled up, so that no dripping takes place.

The advantages of this condenser are very important. *Fully 98 per cent. of the theoretical yield of nitric acid are obtained at a strength of about 96 per cent. monohydrate*, and only about 2 per cent. are collected in the tower as acid of 76° Tw. Thus the yield of strong acid has increased over 3 per cent. One would think at first sight that, by condensing so rapidly, less steam would go into the tower, and that the acid produced must be weaker, but this is not the case. The rapid condensation facilitates the work of the injector and causes a stronger draught on the retort, so that the temperature of distillation becomes still lower, and less water is evaporated. As a matter of fact, the coal consumption can be reduced to 2½ cwt., or about 1 lb. for every 3½ lb. of highly concentrated nitric acid. On the other hand, the percentage of nitrous acid is slightly higher, because there is less time for reaction of the air, but it does not exceed 1 per cent. The consumption of cooling water and air is insignificant. Of the former 50 to 60 gallons per hour are wanted for a double condenser, and the air is consumed at the rate of about 60 cubic feet (at 60 lb. pressure) for the whole charge. The time of distillation has also been reduced to between nine and eleven hours. Both the vertical and the chamber pipes remain quite cool; they get, at most, only lukewarm, so that the possibility of cracking is almost excluded. The condensers occupy very little room, the whole space required for a double condenser, including the collector, being only 8 ft. by 3 ft. 2 in. by 14 ft. high. The cost of the condensers has also been reduced to one-half. A condenser for two retorts, complete with injector, collector, frame, wood tank, rubber rings, flanges, etc., costs about £100, so that the total cost per retort for a 12 cwt. charge is only about £50.

Similar good results are obtained with these condensers when making lower grade nitric acid, and if it is desired to produce perfectly white acid it can be easily done by branching off a hot air pipe into the collector and letting a small current of air constantly go through it during the distillation, to drive off the very small remaining traces of nitrous acid.—*Industries.*

SEPARATION OF MICRO-ORGANISMS BY CENTRIFUGAL ACTION.

By M. R. LEZE.

THE micro-organisms comprise chiefly in their constitution substances heavier than water; these are the albumenoid, cellulosic, and mineral substances, which are isolated by incineration. If the living organisms float in liquids such as wine, cider, or milk, the specific gravity of which borders closely upon unity, it is because they probably contain small quantities of gas, and the force which impels them to rise or sink in a liquid heavier or lighter than their protoplasmic substance is certainly very feeble, regard being had to the very small dimensions of these bodies in question.

But we may intensify this tendency to separation by submitting vessels containing fermentable liquids and organisms to rapid rotatory movement. We have the centrifugal force at command, and can render it several hundred times greater than the intensity of gravitation.

In the laboratory appliances which we employ, the radius and the speed are: in the "lactocrit" turned by hand, 9 c.m. and 3,600 rotations; in the steam turbine (Burmeister's design), 20 c.m. and 4,000 rotations.

In the former apparatus the recipients submitted to centrifugal force are small tubes, drawn out for a certain length in a conical form, and sealed before the lamp at the point. The second apparatus is continuous, and enables us to whiz indefinitely increasing quantities of the liquid in question.

Rotation clarifies fermenting liquids and determines the formation of a glutinous or gelatinous deposit, either at the points of the small tubes or upon the sides of the turbine. On examining these muddy deposits under the microscope, we perceive that they consist chiefly of a heap of living organisms.

By this method we have separated the organisms from a considerable number of liquids in course of fermentation by submitting to the centrifugal zone musts in course of fermentation, decoction of hay, milk, or its serum, after the separation of the cream or of the curd,

saccharine liquids loaded with moulds, wines in acetic fermentation, etc.

The organisms appear to separate the more easily the larger are their dimensions. We can very distinctly isolate the mycelium and the spores of mould and the saccharomyces, while bacteria are only imperfectly separated.

In one of the experiments we passed fermenting cider. The liquid was turbid, but it became perfectly limpid. Samples collected in open or sterilized bottles, and kept in the stove at 30°, all became turbid the next day, and swarmed with bacteria. Yeasts were no longer found, and the alcoholic fermentation had disappeared.

In order to facilitate the separation we may either heat the liquid or add liquids lighter than water, such as ammonia or alcohol. This separation of bacteria may find an application in bacteriological research. In industrial practice we may, perhaps, by means of centrifugal force free polluted or insalubrious waters from the greater part of the organisms present, being careful to admit into the turbine no air but such as has been filtered through a thick layer of cotton.—*Comptes Rendus; Chem. News.*

CHANGE IN THE CHARACTER OF A MINERAL WATER.

By W. P. MASON.

SOME years ago Prof. C. F. Chandler made an analysis of the water derived from the deep well situated at Round Lake, N. Y., a summer resort situated some fifteen miles south of Saratoga. At that time the well was 800 feet deep; the delivery, by pumping, good, and the quality of the water saline and very acceptable. It then analyzed as follows, in grains per U. S. gallon:

Sodium chloride	394·2943
Potassium chloride	9·4363
Sodium bromide	1·4716
Sodium iodide	1·3152
Sodium fluoride	trace
Lithium bicarbonate	2·7494
Sodium bicarbonate	48·9871
Magnesium bicarbonate	9·7846
Calcium bicarbonate	13·4457
Strontium bicarbonate	1·2038
Barium bicarbonate	0·5520
Iron bicarbonate	0·6344
Manganese bicarbonate	0·0768
Potassium sulphate	1·0275
Sodium phosphate	0·0228
Sodium biborate	trace
Alumina	0·0346
Silica	1·2247
Organic matter	trace
	486·2608

Some time since the owners, for reasons known to themselves, undertook to increase the output by sinking the well still deeper. Accordingly the boring was carried to a depth of 1,400 feet, and a tube was inserted the entire length. The cast, and a tube [illegible] was inserted the entire length. The water obtained at this lower level was decidedly different from that previously furnished by the well, and at the same time quantities of gas, sufficient to light the premises, escaped from the tube. My analyses of both water and gas are appended:

(Water results in grains per U. S. gallon.)

Sodium sulphate	0·8584
Sodium chloride	15·7588
Sodium bicarbonate	86·0079
Sodium hyposulphite	0·0119
Sodium hydrosulphide	0·2345
Potassium sulphate	trace
Silica	0·3922
Oxide of iron and alumina	0·0619
Lithium bicarbonate	1·1313
Calcium carbonate	1·0966
Magnesium carbonate	0·9136
	106·4671

The evolved gas consisted of—

	Per cent. by Volume.
Hydrogen sulphide	0·1
Oxygen	0·8
Carbon monoxide	0·3
Nitrogen	3 7
Methane	95·1
	100·0

Rensselaer Polytechnic Institute, Troy, N. Y.
—*Chem. News.*

THE MANUFACTURE OF SODIUM PEROXIDE.

ONLY a few years ago the metal sodium was scarcely known and never seen outside the laboratory, and now, says *Industries*, it is an article of commerce made in considerable quantity and put to the most diverse uses. A large amount is used for revivifying mercury that has "sickened," as it is termed in the *argot* of gold extraction, and some is absorbed in the manufacture of fine chemicals where a powerful reducing agent is required. Already it figures in the lists of chemical dealers as the source of sodium hydrate for analysis, and all chemists who know the difficulty of obtaining this substance fit to use as a reagent take care to make it for themselves direct from the metal. The Aluminum Company, which retains its name somewhat on the *lucus a non lucendo* principle, has sought new outlets for the sodium that was intended to be used in the production of aluminum by the old Deville process until it was rendered obsolete by the advent of cheaper electrolytic methods, and as an outcome of its endeavors has put sodium peroxide on the market as a bleaching agent. It may be readily conceived that a body which has been only a laboratory curiosity, and has chiefly made its existence disagreeably felt by the ease with which it is formed when an attempt to produce absolutely pure NaOH is made—the problem being one which taxed the powers of a Dittmar to the utmost—could not be turned out on a manufacturing scale without much experiment to ascertain the best material for the vessels to be used and the most economical way of carrying out the operations necessary for its formation.

Aluminum, which had before proved faithless to the interests of the company, now came to its aid. It was found that aluminum vessels were not attacked by sodium during its oxidation by the process finally adopted by Mr. Castner, and they were accordingly used. The sodium is contained in aluminum dishes running on rails in an iron tube, which is kept at a temperature of about 300° C. by external heating. Air that has been freed from moisture and carbon dioxide is let into the tube in regulated amount, and the oxidation proceeds slowly and progressively, the air as it enters, containing its normal percentage of oxygen, coming in contact with sodium that is already partly oxidized, and, as it becomes poorer in that element, passing over fresh surfaces of sodium and is thus fully utilized. The vessels are continuously removed at the end where the air enters, and replaced by others newly filled with sodium at the exit end. This continuous character of the process is precisely what should be attained in all methods of chemical manufacture, wherever possible. An intermittent process is an anachronism in the present year of grace, and often an expensive survival to boot.

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